

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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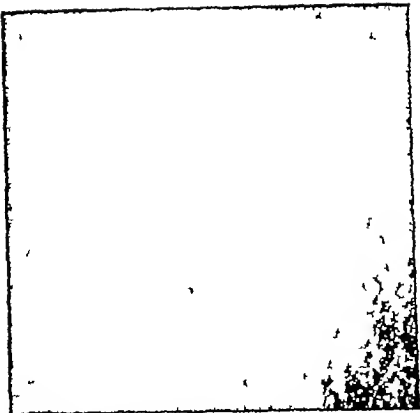
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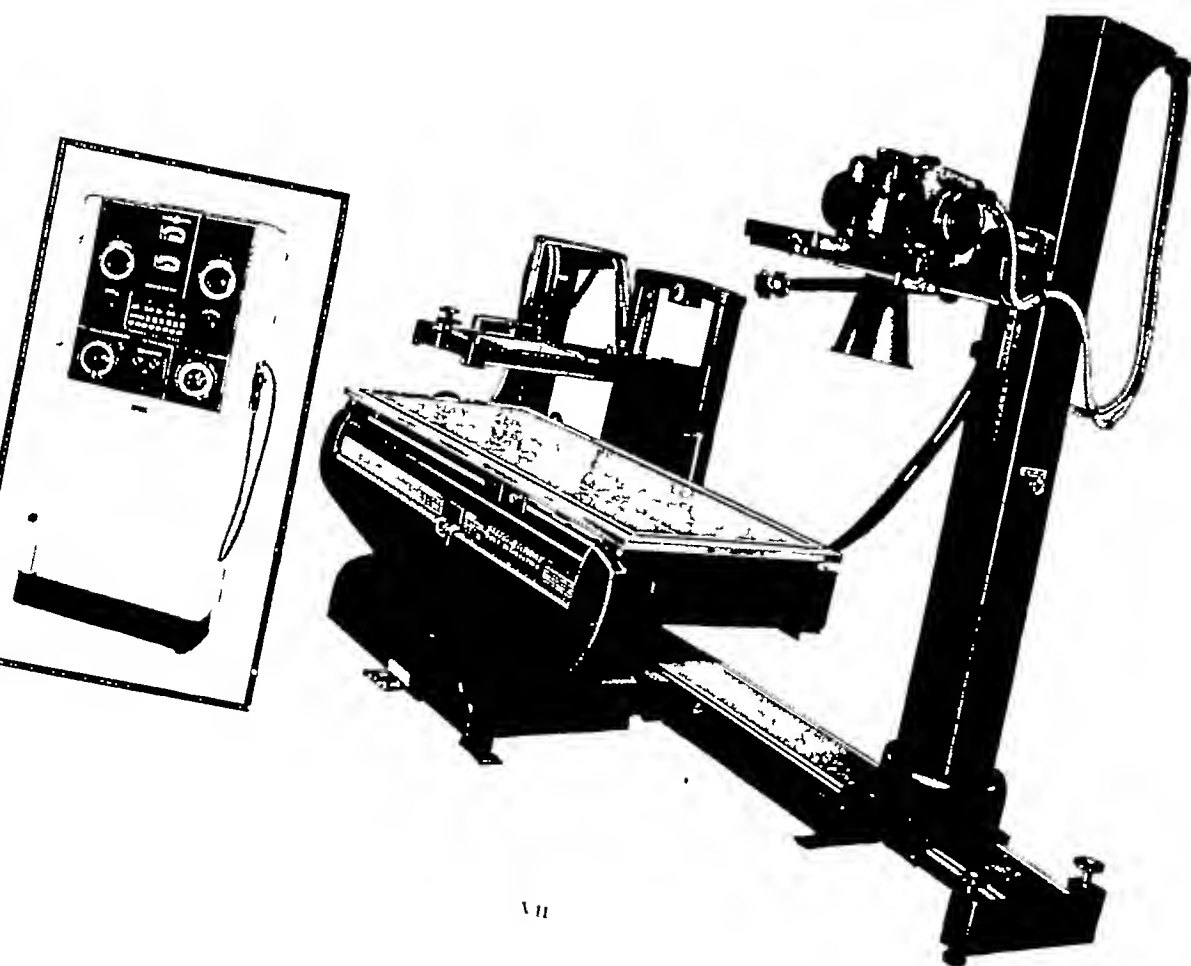
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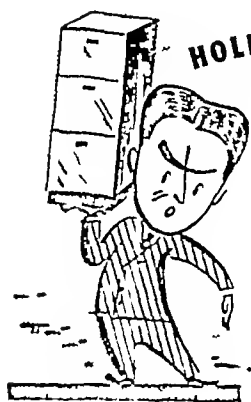
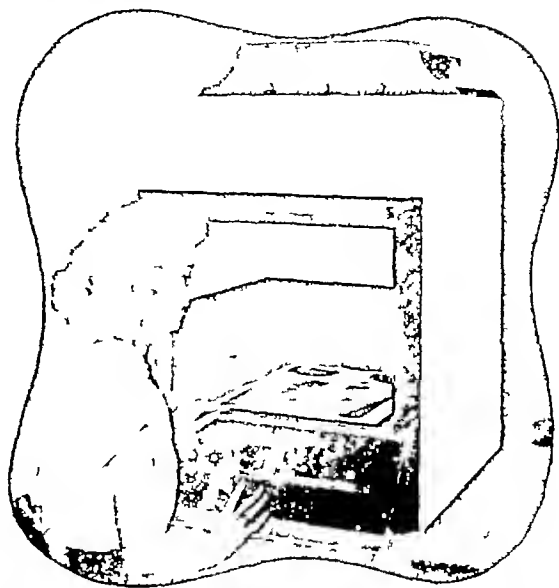
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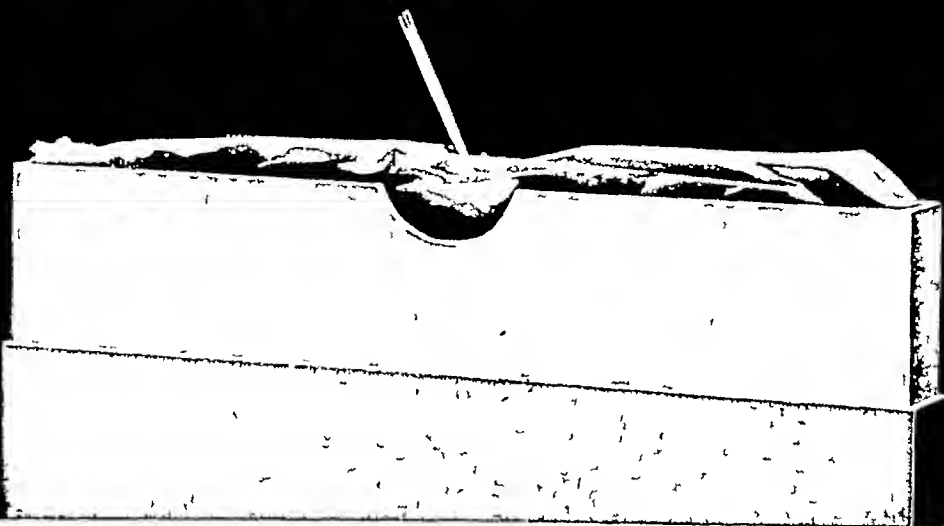
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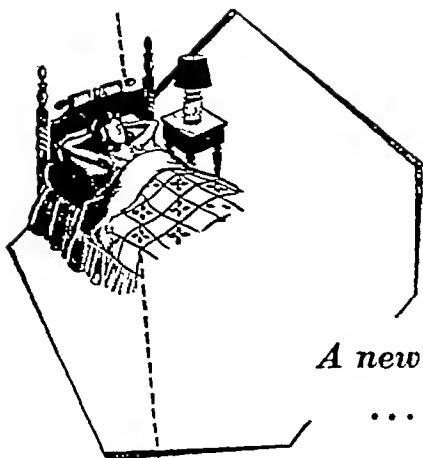
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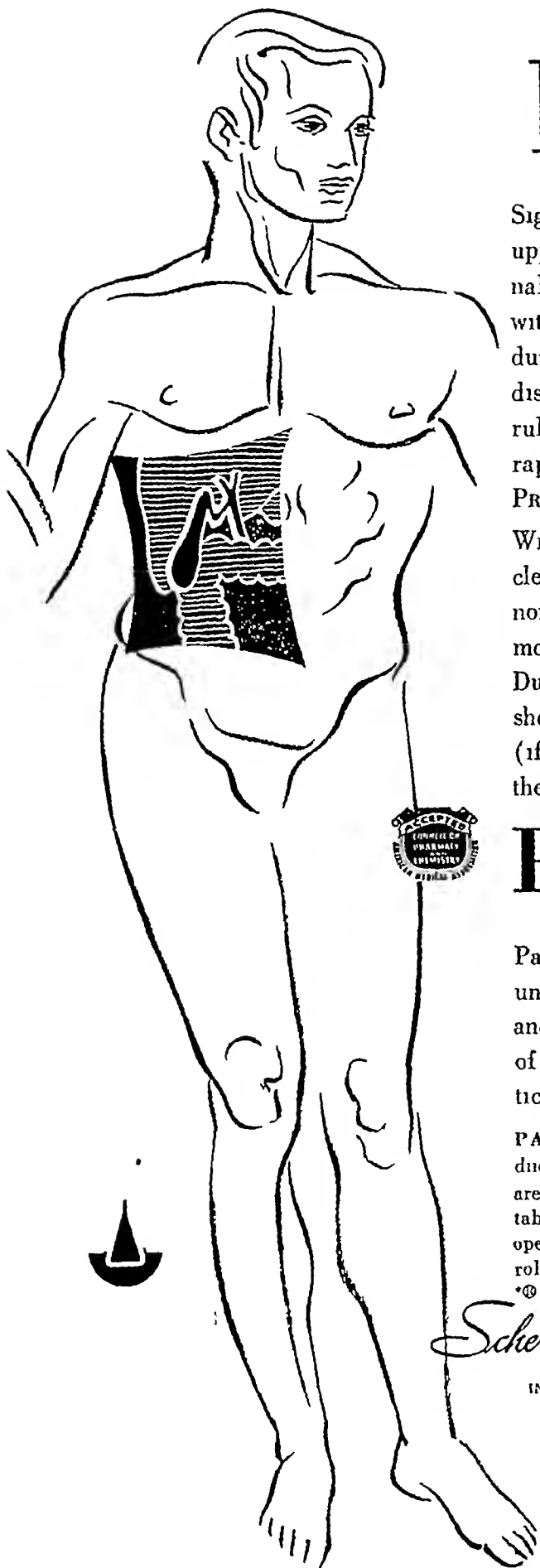
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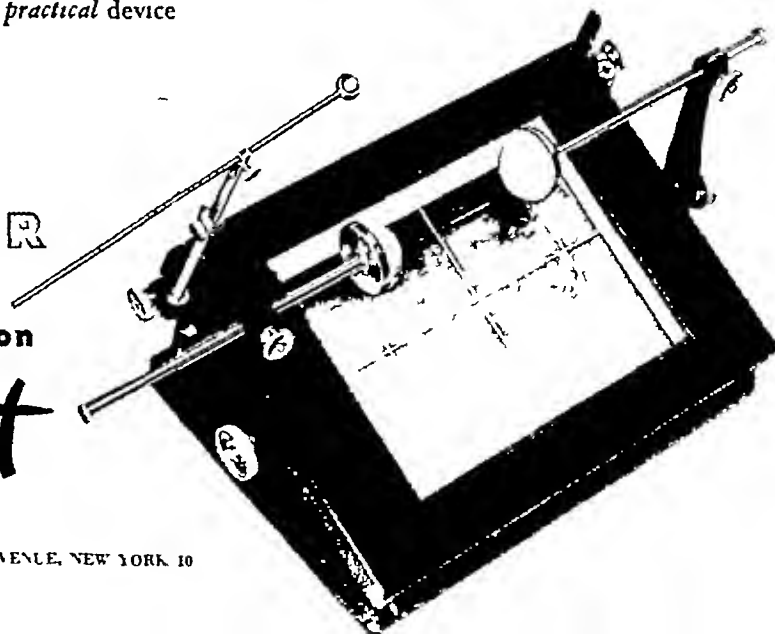
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Medulloblastoma Non-Operative Management with Roentgen Therapy After Aspiration Biopsy¹

C B PEIRCE, MD, MSc, FACP, W V CONE, MD, FRCS, J BOUCHARD, MD, DMRE (Cantab),
and R. C LEWIS, MD

Montreal, Canada

INTRACRANIAL tumors arising during childhood fortunately are not overly frequent. But, too often, the symptoms and signs are not recognized for weeks to months, with the result that by the time the child is brought for definitive treatment, if he is not virtually moribund, his condition is grave. This is especially true with the medulloblastomas, whose common site of origin is in the cerebellum and roof of the fourth ventricle. Further, their history is commonly that of rapid tumor growth and ultimately marked tendency to disseminate throughout the subarachnoid spaces of the brain and spinal cord. Although of all the gliomas—indeed, of all intracranial primary neoplasms—medulloblastoma appears to be the most vulnerable to irradiation, the roentgen and neurosurgical literature is replete with reports of failures to control this tumor.

In the hope that some modification of the management of these cases might effect an improvement in this grim situation, the use of the twist-drill technic developed for ventriculography (W V C) has been employed to afford means of obtaining biopsy tissue for histologic diagnosis in cerebellar tumors. This method

has now been used in a total of 16 cases of suspected cerebellar tumors, with no complications. The results of this type of aspiration biopsy in these 16 cases have certainly proved it to be a necessary and useful procedure, since the tissues obtained showed the following variety:

Medulloblastomas	5
Medulloblastoma, proved to be so at operation	1
Astrocytomas	3
Glioblastomas	2
Abscess	1
Generalized encephalopathy	1
Three cases in which no abnormal tissue was obtained on biopsy but at operation proved to be	
Medulloblastoma	1
Astrocytoma	1
Glioblastoma	1
	<hr/> 16

Thus, knowledgeable differentiation of the medulloblastomas from the astrocytomas and other conditions and decision as to initial surgical attack or intelligent administration of proper roentgen therapy are permitted, with a minimum of trauma, consequently minimal shock and minimal risk of dissemination of the neoplastic cells. This is in contrast to a policy of attempted surgical removal of the major part of the

¹ From the Departments of Neurosurgery and of Radiology, McGill University, Royal Victoria Hospital, and the Montreal Neurological Institute. Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Dec. 1-5, 1947. Submitted for publication in January 1949.

tumor followed by so-called "series" of roentgen therapy, sometimes repetitious and inadequate

The results in our small group of unfortunate children have been encouraging so far

GENERAL CONSIDERATIONS

The problem of management of cerebellar tumors is complex. The relatively slowly growing, localized, more commonly asymmetric astrocytomas, hemangiomas, and some ependymomas, without doubt, are best treated by radical operative intervention (Elvidge, Penfield, and Cone, 1937, Bailey, Buchanan, and Bucy, 1939)

The medulloblastomas present a different situation. The early vomiting is commonly mistaken as indicating a gastrointestinal disorder. The broad stance, widened gait, symmetrical involvement of the lower extremities without gross change in muscular control of the upper limbs, and the "nystagmus" are overlooked for weeks to months. Although there is a greater incidence of medulloblastoma under the age of ten years (Bailey), the less rapidly progressive, but almost as frequent, astrocytoma must be differentiated, if possible, before decision is taken as to the method of treatment. Medulloblastoma is further characterized by relatively rapid growth in usually less than fifteen months, and a rather marked "fertility," as manifest in the ability of some tumor cells to survive considerable irradiation and to propagate further tumors locally and elsewhere along the subarachnoid spaces, wherever they may settle down.

The operative mortality rate is high. Bailey, Buchanan, and Bucy (1939) report 22 per cent in 17 cases, Cushing (1930) 25.2 per cent in 68 cases, Elvidge, Penfield, and Cone 23.6 per cent in 17 cases.

Bailey and Cushing (1925) observed that *without postoperative irradiation*, the average survival was seven months, *with irradiation*, the average was nineteen months. Dyke's (1942) series showed some improvement, 22.3 months. In 11 cases which we have reported for the period

1939-44, the average survival following open operation and roentgen therapy was twenty-two months.

The histologic study of the effect of irradiation on the gliomas by Frazier, Alpers, Pendergrass, and Chamberlin (1937) confirmed the previous clinical observations on the advantage to be gained by irradiation of medulloblastomas. But, also, it emphasized the ability of some of the cells to survive the irradiation applied, and, in time, to resume propagation, with consequent recurrence as well as dissemination of the tumor. Their patients, as practically all others, were subjected to major surgical intervention. The program of roentgen therapy which they employed in the several cases cited demonstrates the groping for some pattern of irradiation which may prove to be less symptomatic and more permanent in the control of this malignant neoplasm. Their histologic data leave little doubt that if the neurosurgeon and the radiation therapist can devise a proper method, medulloblastoma may be controlled.

The type of operation has varied widely. Spitz, Shenkin, and Grant (1947) remove only enough of the tumor to open up the cerebrospinal-fluid pathways. Bailey *et al.*, after operative exposure, take a biopsy for diagnosis and then perform a wide decompression. Cushing advocated thorough local removal by dissection and suction, as did Penfield, Cone, and Elvidge in 1937. Frazier and his associates apparently varied their surgical measures, taking a biopsy only in some at the initial suboccipital decompression, secondarily, subtotal removal of the tumor was apparently essayed.

PRINCIPLES UNDERLYING NEW APPROACH

On the thesis that these children would do as well, and perhaps better, if the trauma necessarily incident upon surgical intervention could be avoided, that the operative mortality would thus be eliminated, that with a histologic diagnosis the medulloblastomas could be sorted out from other posterior-fossa lesions, and thus



Fig 1 Twist-drill hole for ventriculography This procedure is performed in the dressing room immediately prior to ventriculography The child is postured on a cerebellar head rest with a shampoo-board attachment No sedation is necessary One nurse is usually all that is required for restraint The twist-drill set, seen on the table, includes the twist drill, ventricular needles, syringe and needles for injecting local nupercaine, and a small scalpel

Pneumoencephalography is always performed prior to the taking of an aspiration biopsy
Fig 2 Aspiration biopsy technic Side view of suboccipital twist-drill immediately prior to the taking of a biopsy This procedure is also performed in the dressing room immediately off the ward Exactly identical instruments and equipment are used In addition, a No 13 brain biopsy needle is required Landmarks consist of the midline and the line of the greatest bulge of the occipital bone The twist drill opening must be made about 4 cm lateral to the midline and below the line of greatest prominence to avoid important venous sinuses

permit immediate institution of roentgen therapy, one of us (W V C), two years ago, began to perform aspiration biopsies on cerebellar lesions which clinically seemed to be medulloblastomas

Because we believe that aspiration biopsy can be done safely, affording a definite diagnosis in the majority of lesions, and further, that without biopsy many lesions which would respond better to operation than to irradiation would not be sorted out, we cannot agree with Cutler, Sosman, and Vaughan (1936), who favor radiation therapy of suspected cerebellar tumors without histologic diagnosis Also, with such biopsy, no time would be lost (in fact, some four to ten days gained) in the case of the cystic astrocytomas, in which operation is the treatment of choice

Children with medulloblastoma are commonly in a serious and very unfavorable condition and are markedly poor operative risks on admission As noted above, they

are usually less than ten years old and their symptoms have gone unrecognized for weeks to months The five in this particular group (3 girls, 2 boys), varied from nineteen months to eight years of age Symptoms had been present from one to seven months Headache and vomiting were exhibited by 4, difficulty in gait by 4 One complained of defective vision, one had a left internal squint

Upon admission, 3 children were particularly poor operative risks, dehydrated and listless Four revealed bilateral papilledema, the fifth bilateral optic atrophy All had an ataxic gait In 3 cases there was involvement of the pyramidal tracts Three patients had nystagmus and stiff neck One exhibited paresis of the fifth and eighth cranial nerves on one side

VENTRICULOGRAPHIC ORIENTATION

Anatomical location of the tumor was proved in 4 cases by ventriculography

One very urgent case was subjected to biopsy without a preceding ventriculogram. The air studies in 3 of the children were accomplished on the day of admission, the fourth being done after two days observation in the hospital.

The technic for ventriculography at the Montreal Neurological Institute varies in several points from that used in other clinics. Save for the roentgenographic operations, the entire procedure is carried out in the surgical-dressing room adjoining the ward. The child is postured on a cerebellar head rest (Fig 1) with shampoo-board attachment. Bilateral parietal twist-drill holes are placed 4 cm from the midline and one-third the distance from the *inion* to the *glabella*. These can be found again easily if ventricular puncture later becomes necessary. Brain needles (No 18) are placed in the ventricles at the junction of the lateral and posterior horns, the ventricular pressure is measured, and it is ascertained whether or not the ventricles communicate. The ventricular fluid is as completely replaced with oxygen as possible. Roentgenographic studies include the standard positions, but with special manipulation and posing to demonstrate the fourth ventricle.

As soon as the films can be processed and examined, location of the tumor is determined and biopsy is done.

BIOPSY METHOD

The technic of biopsy is simple, providing certain safeguards are observed. The patient is again moved to the surgical-dressing room and postured on the cerebellar head rest (Fig 2). Under local anesthesia, a twist-drill hole (using a No 30 drill), similar to the above, is placed halfway between the *inion* and the *mastoid process*, just below the bulge in the occipital bone. Care is thus taken to avoid the lateral sinus. The biopsy material is then withdrawn by means of a No 15 brain-biopsy needle, inserted not to exceed a depth of 7 cm, directed into the estimated site of the tumor. Biopsy is done *only* if the intracranial pressure is high. This

reduces possible complications from a ruptured vessel. We have already called attention to the facility with which this procedure can be accomplished without complications.

The whole neurosurgical procedure, including shaving the head, can be done in less than thirty minutes, and, including the time for roentgenographic exposures and processing, should not exceed an hour. No draping is required, and no more restraint than can be provided easily by a nurse.

In the case of medulloblastomas, the "brain worms" containing tumor, in the gross, are soft in consistency and have a semitranslucent appearance. The tumor material smears very evenly and smoothly on compression between two glass slides. These smears are then stained with Reid's eosin and methylene blue for quick study. Frozen sections can be made and studied if sufficient material is removed. Not uncommonly an amount adequate to permit fixation and imbedding for standard microscopic studies is obtained.

Histologically there are two types of cells (Figs 3 and 4). Most numerous are the small pear-shaped cells with large darkly staining nuclei and scanty cytoplasm (Fig 5). These often occur in groups around a vessel or in ball formation (Fig 6), with their single processes intermingled in the center. The other type (Fig 7) consists of large tessellated cells with relatively more cytoplasm. These tend to be arranged in a pavement-like fashion. Mitotic figures can usually be observed.

ROENTGEN THERAPY

Upon such confirmation of diagnosis microscopically and determination of the site with, to some degree, the probable size of the tumor, radiation therapy can be instituted intelligently within a very few hours after admission. This is in sharp contrast to the time-consuming and hazardous suboccipital craniotomy and the removal of more or less tumor, with resultant delay of a week to ten days before inauguration of roentgen therapy.

We have advocated for some time

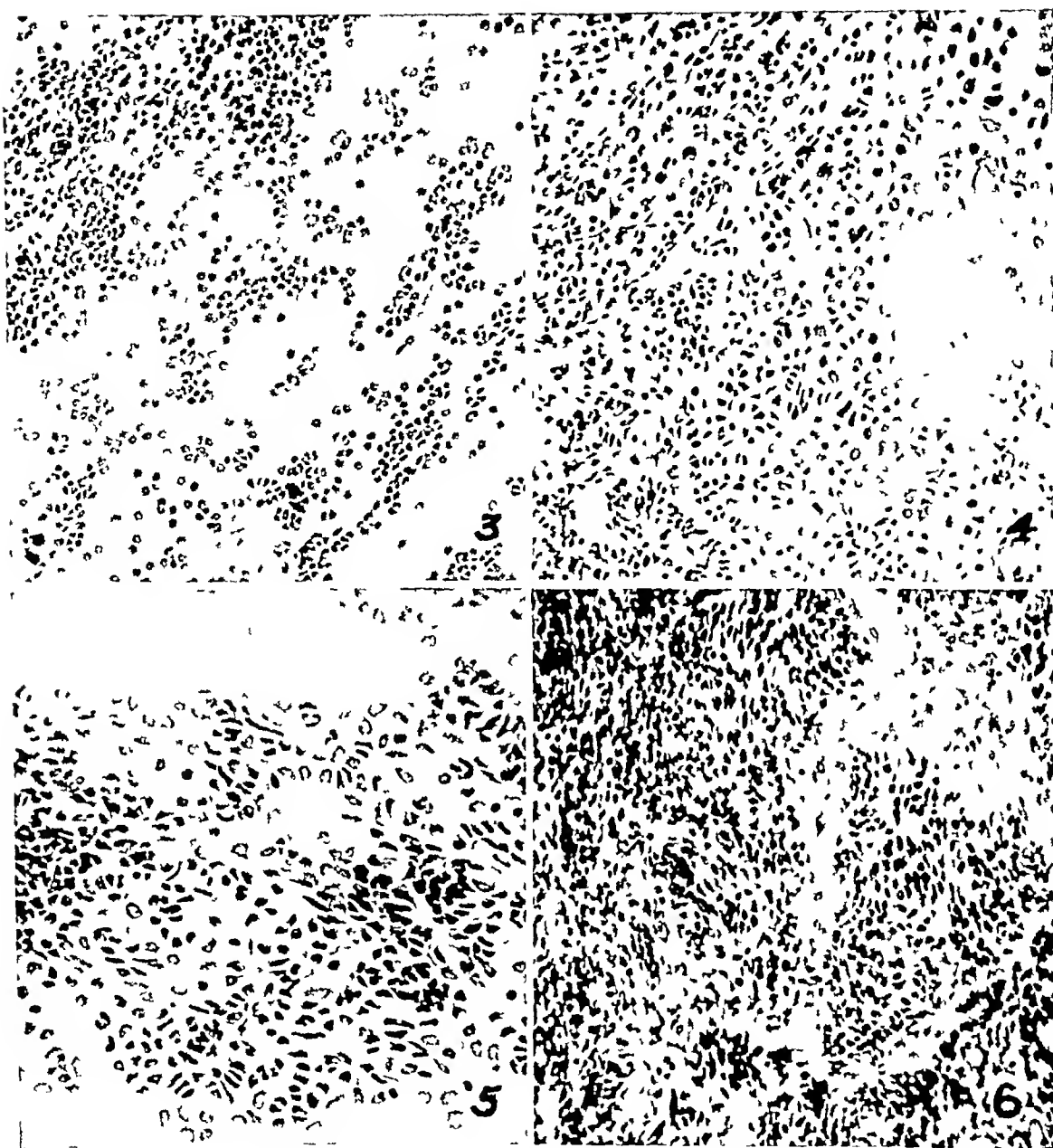


Fig 3 Normal cerebellar smear First note the large Purkinje cells with large central nucleus containing a nucleolus Numerous cytoplasmic extensions of the cell body can be seen Compare the granule cells of the normal cerebellum with the tumor cells shown in Fig 4 The normal cells are small round, of uniform size, and with no tendency to tail formation There is no characteristic architecture, the cells being spread out in odd clumps

Fig 4 Typical medulloblastoma smear (a fairly low-power field photomicrograph) This smear is made immediately on obtaining biopsy material The suspected tissue is placed between two glass slides, which are pressed firmly together and then drawn apart as for a routine blood smear Slides are then fixed with heat and stained with Reid's cosin methylene blue technic which requires only two minutes

Fig 5 Medulloblastoma smear (high-power field) Note the pseudo rosette at the right of the field Note also the tendency of the cells to line up in long cords another architectural pattern often seen

Fig 6 Unusual vascular variation (low-power field) This is a somewhat unusual finding in medulloblastomas Note the increased capillary size and the proliferation of the endothelium

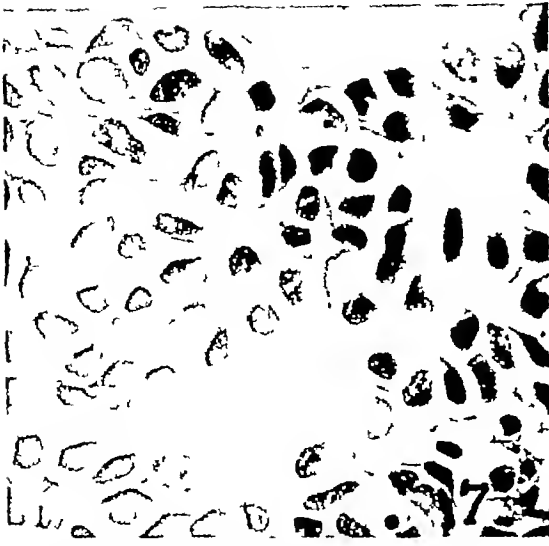


Fig 7 Medulloblastoma smear (detail view) Note again the peculiarly pear shaped cells with the eccentric nuclei and long tail processes. The center of the field demonstrates another pseudo rosette in which the tail processes are intermingled

"maximum tolerable irradiation." In our institutions, repeated periodic incomplete series giving symptomatic relief have been used in the past as elsewhere, but most unsatisfactorily. We considered that a better method must be devised. Therefore, in view of the relative vulnerability of medulloblastoma, and consonant with our experience and belief as to proper irradiation of brain tumors, we (C B P and J B) decided several years ago (late 1940) upon the following program of roentgen therapy.

The primary tumor generally presents no sharp regional demarcation. Because of its location, which is practically occipito-cervical, it tends to protrude through the foramen magnum and extend directly into the uppermost cervical portion of the spinal canal. Loose tumor cells or tumor fragments may spread to any of the subarachnoid spaces above and below the primary lesion and also to the remainder of the ventricular system. This relatively well known fact has a most important bearing on the planning of the size and distribution of ports through which γ -radiation is to be delivered, both to the primary tumor and to possible secondary deposits.

For the treatment of the primary area, the most important field is the central

occipito-cervical (10×15 cm) with the long axis parallel to that of the cervical spine, the central beam directed sagittally. Generally this port covers the occipital region and not less than the upper half of the cervical spinal cord. We are therefore quite sure that the lower extension of the primary growth is not partially omitted, as it easily might be if one used only a small central occipital field. Routinely, right and left temporo-parieto-occipital ports, 10×10 or 6×8 cm each, depending upon the size of the skull, are employed to cross-fire through the tumor and include the basal cisternae and intracerebral spaces. Toward the end of the course, if needed to ease the scalp irritation in other ports, a supraoccipital field (6×8 cm), with the beam directed caudalward, may be added to complete the administration of an adequate tumor dose to the primary area. With exception of the upper cervical portion of the spinal axis, which has already been included in the central occipito-cervical field, the remaining segments of the spinal axis are irradiated with long narrow fields (20×6 cm), down to and including the level of the first sacral vertebra. These spinal fields are usually introduced only upon completion of irradiation of the cranio-cervical portion.

The chief objective is to deliver a tumor dose of not less than 4,500 r to the primary lesion in four weeks. To that effect, doses of 2,200 to 2,400 r, measured in air, are usually given to each of the three major cranial fields specified above. Thus, in the following two weeks, we administer to each segment of the spinal axis 2,000 r, measured in air, with an estimated tumor dose of 1,500 r. Such tumor dose to the spinal subarachnoid spaces may seem small, but the subsequent low incidence of clinical evidence of disseminated tumor development would suggest that this plan is probably adequate to control the rambling cells from medulloblastoma. During the first four or five days of treatment, 100 r only are given daily, to a single port, in order to avoid any undesirable intracranial radiation reaction and systemic upset. Subse-



Fig 8 Baby A, 10 months, was admitted on Sept 24 1945, five months after onset of symptoms. She then had stiff neck, bilateral papilledema, paresis of right arm and both legs, and absence of abdominal reflexes. Ventriculograms made the next day show hydrocephalus, with widening of sutures, enlargement of third and lateral ventricles, distortion of aqueduct and absence of outline of fourth ventricle.

Aspiration biopsy on Sept 26 proved the diagnosis of medulloblastoma. Roentgen therapy was given to the cerebrospinal axis from Sept 28 to Nov 9, 1945. During the last three weeks the child began to play, talk, and move her legs. Papilledema disappeared, size of the head decreased. Readmission for recurrence on April 18, 1946. Second course of x-ray therapy. No post radiation films were made. Death July 17, 1946, ten months after diagnosis was established and treatment instituted.

quently the same dose is delivered to each of two ports a day, to be increased by the beginning of the second week to 150 r, in air, to each of two ports. When the time comes for irradiation of the thoracic and lumbar segments of the spinal axis, a daily dose of 200 r in air per field is suitable.

The other physical factors are as follows: 200 kv, 50 cm FSD, and Thoraeus filter, producing a beam with a half-value layer of 2.0 mm Cu, and effective wave length of 0.115 Å.

RESULTS OF ROENTGEN THERAPY

The impressive immediate results in our 5 patients, whose medulloblastomas were definitely diagnosed by the twist-drill biopsy procedure described above, have prompted this preliminary report.

In these children the pattern of roentgen therapy has been that just outlined, delivering to the primary lesion an average tumor dose of 4,600 r and to every level of the spinal axis an average of 1,500 r.

Within seventy-two hours, in 3 of the 5, the response was dramatic. They became able to feed themselves, were free of headache and, within a week, acted and behaved like normal healthy children. The 2 others took two weeks to manifest the same degree of improvement. The youngest of the group, who had severe secondary hydrocephalus (Fig 8) with marked widening of the sutures, presented a very obvious reduction in size of the head as she began to improve. It is to be noted that ventricular taps were necessary in only one case and then only every other day for five days. During the course of treatment none of the children showed any evidence of aseptic meningitis, a complication which occurs every so often in the postoperative cases. Upon completion of their course of roentgen therapy, all showed disappearance of the majority of their symptoms. The bilateral optic atrophy in the one case could not be expected to change.

A further notable point, on completion



Fig 9 Lise L 7 1/2 years was admitted on March 27, 1947, five months after onset of symptoms with vomiting, headache, ataxic gait, bilateral papilledema, nystagmus, and left hemiparesis.

a and *b* Ventriculograms before aspiration biopsy and x-ray therapy, showing dilatation of third and lateral ventricles and absence of filling of the cisterna magna with gas. The triangular outline of the fourth ventricle is almost completely absent, except for part of the right side (anteroposterior view), indicating a space-filling tumor larger on the left than on the right side.

Aspiration biopsy Medulloblastoma.

From March 28 to May 7, 1947, roentgen therapy was given to the cerebrospinal axis. Symptoms and signs disappeared and the child has remained well ever since.

c and *d* Pneumoencephalograms immediately after course of roentgen therapy. Note the free communication between spinal canal and ventricular system, clear outline of cisterna magna, fourth ventricle, aqueduct and most of the third ventricle.

of irradiation, was the pneumo-encephalographic demonstration of regression of the tumor as indicated mostly by the resumption of free cerebrospinal circulation of gas

through the upper cervical spinal canal, the fourth ventricle and cisterna magna, and, finally, to the upper cerebral spaces (Figs 9-11).

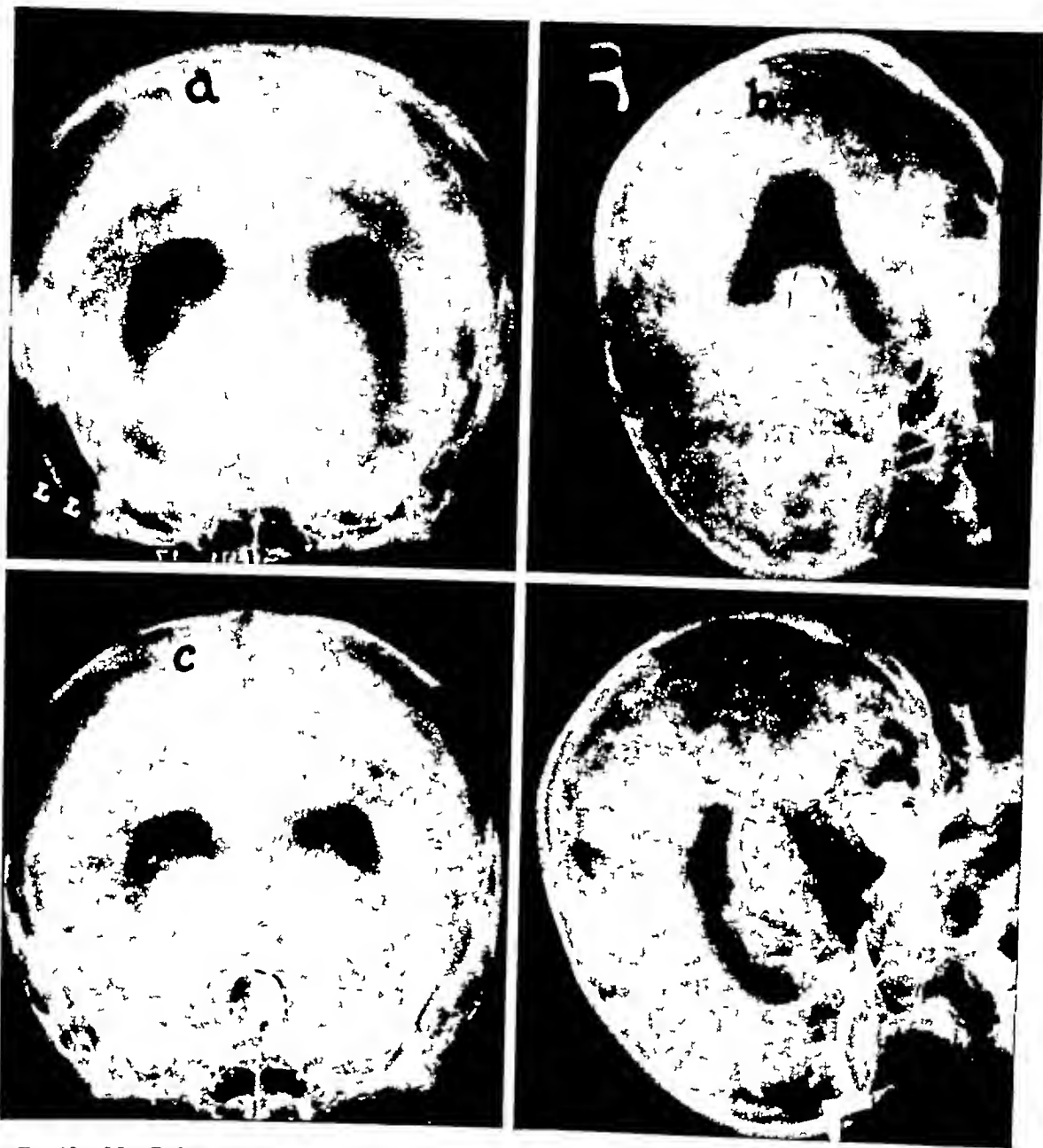


Fig 10 Miss P 8 years old, was admitted on June 17 1947 with headache vomiting bilateral optic atrophy and ataxia Pneumography was done on the day of admission but the ventricles did not fill The procedure was repeated successfully on June 19

a and b Ventriculograms before aspiration biopsy and roentgen therapy showing slight enlargement of lateral ventricles and on the lateral projection blockage of the aqueduct of Sylvius as well as absence of outline of cisterna magna and fourth ventricle

Immediately afterwards aspiration biopsy showed a medulloblastoma

On the same day roentgen therapy was initiated and the entire cerebrospinal axis was irradiated in thirty-seven days Neurologic signs cleared up except for poor vision and optic atrophy The patient is still in the same improved condition

c and d Encephalograms after roentgen therapy showing apparently normal ventricles On the lateral projection made in the "brow-down" position the cisterna magna was filled with gas but the fourth ventricle which usually shows best in this lateral projection was not seen On the "brow up" lateral projection (*d*—shown inverted for comparison), all basal cisternae are nicely outlined indicating regression of the tumor

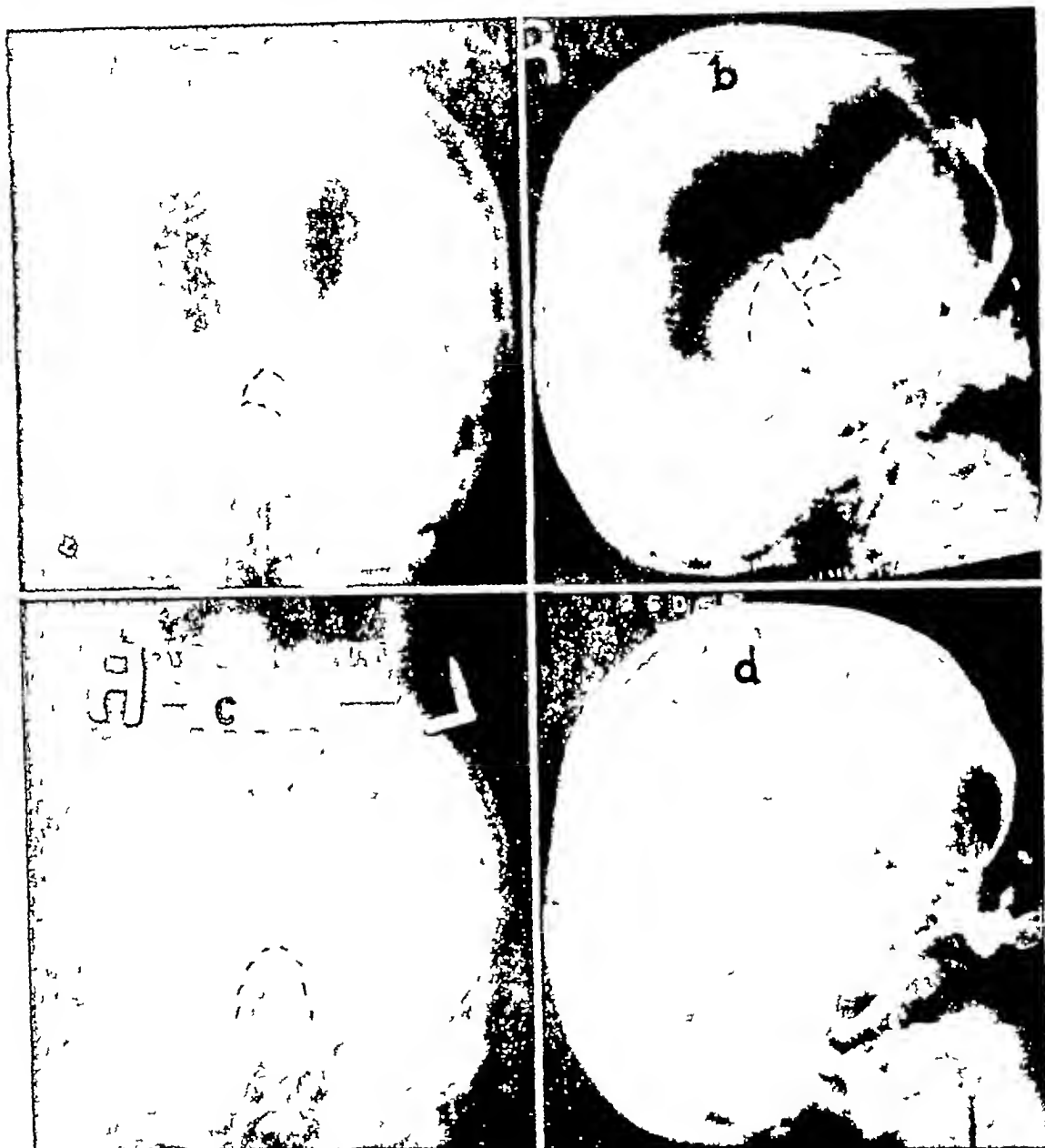


Fig 11 \ G 6 years old, was admitted July 4 1947 seven months after apparent onset of trouble \ omitting ataxia headache bilateral papilledema, and nystagmus were noted

a and b Ventriculograms before aspiration biopsy and roentgen therapy showing widening of cranial sutures, marked enlargement of lateral and third ventricles and proximal part of aqueduct, absence of proper visualization of cisterna magna and fourth ventricle indicated a tumor located in the region of the fourth ventricle

Aspiration biopsy was carried out, and the presence of a medulloblastoma was proved

Roentgen therapy was administered from July 5 to August 11 1947 On completion of irradiation papilledema and nystagmus had gone

c and d Encephalograms after roentgen therapy free circulation of gas between spinal canal and intracranial subarachnoid spaces and also into the ventricular system Cisterna magna is well filled with oxygen, and the fourth ventricle sharply outlined although the latter seems to be projecting slightly more forward than usual

The first patient treated by this method is still alive and acting as a normal, bright child at the end of two years, during which he has received two more similar courses

of \-radiation, each time because of early signs of tumor recurrence One of the 2 children whose response to irradiation was slow died nine months later from recur-

rence This was a babe of nineteen months whose symptoms had gone unrecognized for five months The other 3 (Figs 9-11) have been under our observation only nine, six, and four months

It is too soon, and the number of cases too small, to permit more than a preliminary report on the procedures followed and the immediate results Only time will tell the real value of our methods² At any rate, each of these 5 patients, who were very poor surgical risks for an operation which carries an average mortality of 25 per cent, had the benefit of a confirmed diagnosis in a most simple way and, as a result of roentgen therapy instituted immediately thereafter, dramatically recovered from a most critical condition To our thinking, this has been worth while

SUMMARY

Twist-drill aspiration biopsy of suspected cerebellar lesions can be accomplished simply and safely, but should be done only after careful clinical and ventriculographic orientation of the suspected tumor site The findings must be so definite as to place the tumor in the posterior fossa

Such diagnosis of tumor type will sort out the major number of medulloblastomas from other tumors or non-malignant lesions which are better treated surgically Although some may believe that little is to be gained by biopsy, with the technic described a high percentage of posterior fossa lesions can be identified positively and quickly before the method of treatment is decided upon Further, at least four to ten days can be gained in the case of an astrocytoma by elimination of the time loss of a therapeutic trial of irradiation

Within three to four days under roentgen therapy these children are sufficiently

² In January 1949, 37 months after initial treatment with x radiation, the first patient treated by this method was still alive and, in his parents' opinion, well although he has had recurrences which have been treated in the same manner as originally The patients whose cases are illustrated in Figures 9 and 10 are alive and well, twenty two and nineteen months respectively, after the onset of treatment they have had no recurrence so far Patient V G (Fig 11) was clinically well for six months after treatment, then died suddenly as the result of an automobile accident

improved to respond more normally Consequently the improvement made possible in their nutritional state relieves major concern as to their fluid balance and general medical condition Shortly thereafter they are able to care for themselves in an appreciable degree

Ventricular tap may be required during the initial days of treatment, but should not be necessary after the fifth day

Roentgen therapy should be initiated immediately upon diagnosis of medulloblastoma, but conservatively as in all intracranial tumors The program of treatment should be planned, however, to deliver an adequate tumor dose, in our opinion "the maximum tolerable dose," to the primary area and a considerable portion of such a dose as a prophylactic measure to every level of the spinal axis This is in contrast to other methods of repeated and oftentimes incomplete irradiation at variable periods

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DISCUSSION

Joseph H Marks, M D (Boston) The paper by Dr Peirce and his associates from Montreal seems to me to record a very definite advance in the management of cerebellar medulloblastomas. I believe there can be little doubt that they have taken a real step forward in their diagnostic procedure, but more time must elapse and a larger number of cases be followed before the wisdom of their choice of dosage is demonstrated. Their first patient had two recurrences within two years in spite of 4,500 r to the primary tumor. Obviously one cannot deliver that dose to the same area very many times. Additional study may indicate that a smaller dose is equally effective.

In defense of my friend and teacher, Dr Merrill Sosman, I should like to point out that it was his contention that the response to radiation would in itself differentiate between the relatively sensitive

medulloblastoma and the resistant astrocytoma. The damage to the patient and the discredit of the procedure derived from the fact that too long a period of time was allowed to pass before the astrocytomas were brought to operation.

Carleton B Peirce, M D (closing) I wish to thank Dr Marks for his comments, but apropos his remarks with respect to Dr Sosman's opinion, I believe it was he who considered it did not matter whether one takes a biopsy or not. In contrast, one of the points we believe to be important is that the possibility of so simply differentiating astrocytomas with aspiration biopsy will afford a gain of at least ten days in selection for early surgical treatment, and, by the same token, early diagnosis with a minimum of trauma and of delay will afford the child with medulloblastoma the best chance for effective roentgen therapy.

SUMARIO

Medulloblastoma Tratamiento No Operatorio con la Roentgenoterapia Consecutiva a la Biopsia Aspiratoria

La biopsia aspiratoria con la técnica del taladro salomónico representa un método eficaz en las lesiones cerebelares sospechosas para separar los medulloblastomas radiosensibles de otros tumores o lesiones no malignas que se tratan mejor con la cirugía. Sin embargo, sólo debe practicarse tras la cuidadosa orientación clínica y ventriculográfica del asiento del tumor sospechoso con hallazgos suficientemente precisos para localizar el tumor en la fosa posterior. El procedimiento entraña un mínimo de traumatismo, y por consiguiente mínimo choque y mínimo riesgo de diseminar células neoplásicas, y permite la rápida aplicación del tratamiento apropiado. Tratándose de medulloblastomas, puede iniciarse la roentgenoterapia en término de pocas horas, en marcada contraposición a la demora y el peligro que encierran la craneotomía suboccipital y la extirpación del tejido tumoral. Si se descubre un astrocitoma, pueden ahorrarse a lo menos cuatro a diez días por la eliminación de un ensayo terapéutico de la irradiación antes de operar.

El esquema de los AA para la roentgenoterapia en el medulloblastoma, aunque conservador, requiere la "dosis tolerable máxima" en la zona primaria (no menos de

4,500 r en un período de cuatro semanas), y dosis más pequeñas (2,000 r al aire) como profiláctico a cada nivel del eje raquídeo, lo cual contrasta con otras técnicas de irradiación repetida y a menudo incompleta a períodos variables.

Comunicanse cinco casos de medulloblastoma, diagnosticados con la técnica del taladro salomónico y tratados con la irradiación roentgen en la forma descrita. La edad de los enfermos variaba de diecinueve meses a ocho años y la duración de los síntomas de uno a siete meses. Todos los pacientes eran malos riesgos quirúrgicos. La respuesta al tratamiento fué teatral. En término de una semana, tres ya se portaban como niños sanos y normales, mientras que en los otros dos la misma mejoría exigió dos semanas. Sólo en un caso se necesitaron punciones ventriculares durante los días iniciales del tratamiento. Un niño murió de recurrencia a los nueve meses del tratamiento, uno se hallaba vivo y aparentemente bien a los treinta y siete meses, habiendo recibido, entre tanto, más roentgenoterapia por recurrencias, dos se hallaban vivos y bien a los veintidós y diecinueve meses de la iniciación del tratamiento, el quinto murió de otra causa.

Accuracy of Roentgen Diagnosis of Benign Gastric Ulcer¹

C A STEVENSON, M D,² and C W YATES, M D³

RADIOLOGISTS, surgeons, and clinicians have found through experience that a certain number of gastric lesions diagnosed by roentgenologic methods as benign gastric ulcer have later proved to be carcinomatous. In the medical literature this diagnostic error is quoted as being from 5 to 20 per cent.

From the maze of published material concerning benign gastric ulcer and its relationship to gastric carcinoma, a few conservative opinions may be gathered, although many of these will be argued pro and con until further study clarifies the whole cancer question. Briefly, the points of view expressed in the literature might be summarized as follows:

1 *Nomenclature* Due to differences in course, prognosis, treatment, and possibly etiology, benign gastric ulcer and duodenal ulcer should be classified separately and not grouped as "peptic ulcers."

2 *Etiology* Numerous theories have been advanced for the etiology of both gastric ulcer and gastric carcinoma, but the question still remains open.

3 *Incidence of Gastric Carcinoma* According to the best available figures, approximately 40,000 people die annually in the United States from gastric carcinoma.

4 *Incidence of Malignant Transformation in Benign Gastric Ulcer* Figures can be quoted from the literature to show (a) that cancer rarely, if ever, develops in benign gastric ulcer, (b) that it may occur in a few cases, or (c) that it occurs in as high as 90 per cent of the cases. Probably the figures of Stewart are most widely accepted. According to these, 9.5 per cent of cases of chronic gastric ulcer become carcinomatous and 17 per cent of gastric carcinomas originate in chronic ulcers. However, several

prominent radiologists are of the opinion that gastric carcinoma does not develop from benign gastric ulcer.

5 *Symptomatology* There is no single symptom or group of symptoms that can be relied upon to differentiate the benign gastric ulcer from the malignant gastric ulcer.

6 *Age and Sex* Although in a large series of cases the average age for patients with gastric carcinoma will be slightly higher than for those with benign gastric ulcer, this observation is of little value as applied to the individual case. Sex is of no significance in differential diagnosis.

7 *Clinical Laboratory Tests* At this time there are no laboratory tests which will differentiate between gastric carcinoma and gastric ulcer. The single exception to this statement is the identification of a piece of tumor tissue obtained by gastric lavage, and clinical pathologists are now attempting to diagnose carcinoma of the stomach on the basis of single cells thus obtained. This test is related to Papanicolaou's work on the cytological diagnosis of cancer of the cervix and uterus. Many difficulties can be expected. The pathologist must acquire a great deal of experience in this procedure, and the surgeon may have a real problem if the cytological test reveals cancer cells and the roentgenologic and gastroscopic examinations do not demonstrate a lesion. The degree of gastric acidity is of no differential value in the individual case.

8 *Location of Ulcer* It is generally agreed that an ulcer on the lesser curvature of the stomach in the mid portion has the greatest chance of *not* being malignant. Prior to 1936, it was believed that ulcers occurring in the prepyloric region showed

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Fig 1 Syphilitic ulcer in the distal third of the stomach on the greater curvature side
 Fig 2 Complete disappearance of ulcer crater after thirty days of antisyphilitic therapy

a higher incidence of malignancy. However, following the work of Singleton (1), later confirmed by Kirklin and MacCarty (2), the opinion now held is that the probability of malignancy in a roentgenologically demonstrable ulcer in the prepyloric region is no greater than in an ulcer in another site in the stomach. A warning should be sounded here that the opinion still exists that four out of five prepyloric lesions are malignant. Ulcers on the posterior wall distant from the lesser curvature are prone to be malignant and approximately 96 per cent of those on the greater curvature are malignant. The list of reported benign gastric ulcers on the greater curvature is increasing, especially in association with positive serologic tests for syphilis (Figs 1 and 2).

9 *Size* MacCarty (3) has done considerable work with reference to the relationship between the size of a gastric ulcer and malignancy. He has shown, and his view is widely accepted, that an ulcer measuring 2.5 cm or more in diameter is

very likely to be malignant. However, size alone cannot be taken as a criterion, as approximately 6 per cent of resected carcinomas are less than 2.5 cm in diameter, and many benign ulcers attain larger dimensions.

10 *Medical versus Surgical Treatment* With the improvement in the mortality rate for gastric resection, there is an increasing number of surgeons who advocate immediate surgery for all gastric ulcers. They argue that, inasmuch as 10 to 12 per cent of gastric ulcers diagnosed as benign by roentgenologic methods are actually malignant, while the mortality rate for resection is much lower than this, surgical treatment should be employed as soon as possible. The medical clinicians argue that less than 10 per cent of ulcers are malignant and a therapeutic trial of conservative measures should be given, with strict criteria for healing, prior to surgery. They also cite the growing number of surgical "cripples" following resection as an argument against immediate surgery in all

cases Criteria for healing of an ulcer under rigid observation have been set up (1) complete healing as shown by roentgenologic examination, (2) disappearance of all symptoms, (3) absence of occult blood in the stools

11 *Gastroscopy* To all but a few enthusiasts, gastroscopic examination is viewed as a supplement to roentgenologic examination rather than a rival method Given a lesion of the stomach visible by the gastroscope, this method is slightly more accurate than roentgen examination However, gastroscopy alone is probably no more accurate, and is more complicated and more dangerous to the patient, than roentgenologic examination

12 *Roentgenologic Examination* Kirklin (4) has aptly stated the service rendered by roentgenologic study of the stomach as follows

- (1) As a rule, it can be relied upon to disclose any existing ulcer regardless of manifestations
- (2) It has a proportionate exclusion value when clinical data indicate the presence of an ulcer
- (3) It demonstrates the exact site of an ulcer
- (4) It will determine the presence or absence of complications
- (5) It will reveal the number, depth, and surface extent of ulcers
- (6) It will distinguish, or assist materially in distinguishing, ulcers from other lesions, and benign from malignant lesions

ROENTGENOLOGIC SIGNS OF ULCER

The basic sign of an ulcer is the barium-filled crater, the niche, or its exaggerated form, the accessory pocket When the ulcer is situated favorably and is seen in profile, it appears as a bud-like prominence projecting from the barium-filled stomach It commonly projects beyond the normal line of the gastric lumen When seen face on, with the gastric walls approximated, the crater appears as a rounded dense spot amid the rugal markings, with the rugae commonly converging on this spot



Fig 3 Large meniscus sign due to metastatic melanoma-epithelioma, primary on the left leg

Secondary manifestations are usually present, but unless the crater can be demonstrated, a diagnosis of ulcer is not justified Accentuated and irregular gastric rugae about the ulcer, tenderness to pressure over the region of the crater, active peristalsis and gastrospasm in various forms are commonly observed Curling of the pyloric end toward the midline, with the stomach assuming a hook form, and an eccentric position of the pyloric canal have also been listed as secondary findings We have observed the latter condition so frequently without evidence of pathologic change in the stomach that it is difficult to attach much significance to it

In differentiation, the malignant ulcer usually has a demonstrable elevation of the border about the ulcer, the ulcerous cavitation is within the normal line of the gastric lumen, the margins are often irregular and undermined, and the surrounding rugae may be effaced The adjoining gastric wall may be infiltrated and appear



Fig 8 Case III Ulcer on lesser curvature side of the middle third of the stomach. Note area of spasm on the greater curvature side opposite the ulcer. This is usually found only in association with a benign ulcer.

CASE II C H, white male, farmer, age 57, was first seen in March 1944, complaining of weakness of one month duration. He had fainted while visiting his home physician and subsequently received medication for anemia. Three weeks previously he had vomited bright red blood and had passed dark stools since that time. There had been anorexia and a 10-pound weight loss in the past month.

Serologic tests were negative. The red cell count was 4,120,000, white cell count 13,200, hemoglobin 66 per cent. The urine was negative. The sedimentation rate was 55 mm/hr. Roentgen examination showed "a penetrating type of ulcer with a crater measuring 1 X 2 cm on the posterior wall of the upper one-third of the stomach" (Fig 6).

The patient went home, on an acute ulcer regime, and returned six weeks later. X-ray examination showed the ulcer still present, but smaller than at previous examination (Fig 7). Surgery was advised. The surgeon's opinion was benign ulcer, and frozen section confirmed this, but later microscopic study showed an ulcerated adenocarcinoma, grade III, with almost complete penetration of the posterior wall but with no evidence of lymph node metastasis.

CASE III L R S, white male, farmer, age 54, was seen in October 1944, complaining of epigastric pain for the past ten months, which had no relationship to meals and was unrelieved by alkalis. Physical examination and laboratory examination revealed little of significance.

X-ray examination revealed a non-functioning gallbladder. In the stomach there was a defect on the posterior wall in the middle third, which was thought to represent a gastric ulcer (Fig 8).

Hospitalization with a strict medical regime was advised. If no improvement occurred, surgical exploration was to follow. This advice was refused and the patient returned home.

Follow-up letters reported several episodes of hematemesis. The patient was operated upon elsewhere, in July 1945, at which time an adenocarcinoma of the stomach was found.



Fig 9 Case IV Typical benign gastric ulcer on lesser curvature side in the upper third of the stomach. See also Figs 10 and 11.

CASE IV Mrs C W, white female, age 53, was first seen in December 1941, complaining of stomach trouble. Six months previously, following strenuous exertion, she had had an attack of vertigo and became nauseated. Following this she passed large tarry stools. Dark stools were noted daily, up to the time of admission.

Physical examination and laboratory tests were non-contributory except for a mild anemia. Gastric analysis showed free acid 37, combined acid 15, total acid 52.

The x-ray report read "There is a small gastric ulcer 1 cm in diameter, high on the lesser curvature near the cardia. This is a typical benign ulcer but the location is unusual" (Fig 9).

The patient was advised to remain under observa-



Figs 10 and 11 Case IV

Fig 10 Complete disappearance of ulcer shown in Fig 9 after thirty days of medical treatment
 Fig 11 Large carcinoma the proximal border of which is near the site of the original ulcer (Fig 9) This is five months after healing of the ulcer was demonstrated

tion in the hospital for two weeks, with re-examination at the end of that time. She refused, went home, and returned for observation Jan 9, 1942. X-ray examination at that time showed a slight defect at the site of the previous ulcer, interpreted as scarring from that process. The ulcer was apparently healed (Fig 10).

The patient returned June 21, 1942, six months following the original examination, stating that three days previously she had had another attack of vertigo followed by tarry stools. She had lost 17 pounds since the last visit. X-ray examination revealed extensive scirrhous carcinoma involving the middle third of the stomach (Fig 11). Surgical exploration on July 1, 1942, showed "fibrocarcinoma of *linitis plastica* type, grade III, of the mid portion of the stomach, with some involvement of the perigastric lymph nodes."

CASE V W W McC, white male, age 72, a college instructor, was first seen in July 1938, complaining of epigastric pain of eighteen months duration, with gradual loss of weight. He had had considerable vomiting but no hematemesis or melena.

X-ray examination after lavage and antispasmodics was reported as follows: "The stomach contains a large amount of secretion. Unable to get any barium through the outlet of the stomach. There is a persistent defect on the lesser curvature of

the stomach which is consistent with a large gastric ulcer that may be malignant" (Fig 12).

Surgery was advised but was refused, and the patient returned home. He was operated upon elsewhere six months later and died at the time. Operative findings were extensive carcinoma involving the entire stomach and lymph nodes, with peritoneal implants and nodules in the liver.

CASE VI P E E, white male, age 46, farmer, was first seen in March 1945, complaining of abdominal pains of four to five years duration. Pain had increased recently but was relieved by milk.

X-ray examination showed "a large penetrating gastric ulcer high on the lesser curvature, the ulcer is about 5 cm in diameter and because of its size, malignancy should be considered. Marked hypertrophy of the gastric rugae" (Fig 13).

On surgical exploration, a carcinoma of the stomach with lymph node metastases was found.

CONCLUSIONS

- 1 The experienced radiologist is able, by adequate fluoroscopic examination, to be highly accurate in the diagnosis of benign gastric ulcer.
- 2 In a series of 91 adequately followed



Fig 12 Case V Large ulcer on lesser curvature side, in the middle third of the stomach

gastric ulcer patients, the roentgenologic report of a benign lesion was accurate in 93.4 per cent

3 In spite of various criteria for the differential diagnosis between benign gastric ulcer and gastric carcinoma, we are unable, on reviewing the roentgenograms and the fluoroscopic findings, to find any difference in the six malignant cases erroneously diagnosed as benign, as compared to the proved benign ulcers in this series. We believe, therefore, that it is impossible, at any one roentgenologic examination, to definitely differentiate a gastric ulcer from a gastric carcinoma. However, if adequate criteria for benignancy are kept in mind, this single procedure is about as accurate as any test in the field of medicine.

4 No particular fault can be found from a roentgenologic standpoint, with either the medical or surgical procedures

needed to enhance the accuracy of the roentgenologic diagnosis. However, since it is a well known fact that a roentgenologic diagnosis of gastric carcinoma implies a very poor prognosis, it may be wise to consider seriously immediate surgery for



Fig 13 Case VI Large broad based ulcer on lesser curvature in the upper third of the stomach

all cases of roentgenologically diagnosed benign gastric ulcer, in the hope of early removal of the carcinoma in the approximately 10 per cent of cases in which the diagnosis is wrong.

Scott and White Clinic
Temple Texas

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SUMARIO

Exactitud del Diagnóstico Radiológico de la Úlcera Gástrica Benigna

En una serie de 91 enfermos con úlcera gástrica, mantenidos en observación adecuada, el informe roentgenológico de lesión benigna resultó exacto en 93.4 por ciento. Las historias de los seis casos que resultaron malignos aparecen aquí.

A pesar de varias pautas para el diagnóstico diferencial entre úlcera y carcinoma del estómago, los AA no pueden, después de repasar las radiografías y los hallazgos roentgenoscópicos, encontrar la menor diferencia en los seis casos malignos, diagnosticados erróneamente como benignos, comparados con los de úlcera benigna comprobada en la serie. Creen, pues, que es imposible, con ningún examen roentgenológico, diferenciar definitivamente una úl-

cerá gástrica de un carcinoma gástrico. No obstante, si se tienen en mente pautas adecuadas para la benignidad, este procedimiento viene a ser tan exacto como cualquiera de las otras pruebas utilizadas en la medicina.

Siendo bien sabido que un diagnóstico roentgenológico de carcinoma gástrico denota un pronóstico muy malo, acaso sea prudente considerar con seriedad la cirugía inmediata en todo caso de úlcera gástrica benigna diagnosticada roentgenológicamente, con la esperanza de extirpar cuanto antes el carcinoma en el 10 por ciento aproximado de casos en los que el diagnóstico es erróneo.



Fibrous Dysplasia of Bone (Monostotic)¹

Col PAUL O WELLS, MC

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FIBROUS DYSPLASIA occupies a rather prominent position among those bone lesions which frequently owe their detection to an incidental radiologic examination. In the absence of subjective symptoms or objective clinical findings, the radiologic evidence is then the only indication of skeletal disease. The accuracy of the radiologic diagnosis is not well established, and many investigators have expressed the view that the roentgen findings are not specific and therefore not reliable. Schlumberger (20) emphasized the fact that in none of the sixty-nine cases studied by him at the Army Institute of Pathology during World War II was the possibility of fibrous dysplasia entertained by the radiologist.

Our experience at Brooke General Hospital has led us to believe that the diagnosis can be arrived at with relative ease on the basis of the radiologic appearance of fibro-dysplastic lesions. Our observations do not indicate, however, that the radiologic features of fibrous dysplasia are always specific or pathognomonic. It is our intent in this presentation to review proved cases of monostotic fibrous dysplasia observed at this hospital during the last two years and to discuss the most frequent and relevant roentgen diagnostic criteria.

HISTORICAL

This relatively common bone lesion has had many diagnostic terms applied to it in the past. The most frequently used include "osteitis fibrosa cystica localisata," "fibrocystic disease of bone," "bone cyst," "osteodystrophia fibrosa," "fibro-osteoma," and "fibroma of bone." Other unrelated conditions have also been thought to belong to this group of bone diseases.

The clinical syndrome characterized by

multiple bone involvement, pathological pigmentation of the skin, and precocious puberty in the female was described in this country by McCune and Bruch (16) and also by Albright and his associates (1). It was to the bone lesions in this syndrome that Lichtenstein (14) first applied the name "fibrous dysplasia." In a subsequent publication by Lichtenstein and Jaffe (15) the term was extended to include those cases of monostotic involvement in which the bone lesion showed the same histologic characteristics but there were no extraskeletal manifestations. These writers expressed the opinion that the two varieties, monostotic and polyostotic, represented different degrees of severity of the same pathological entity and suggested that the basic disorder was due to perverted activity of the specific bone-forming mesenchyme.

Further contributions to our understanding of this disease have been made by Furst and Shapiro (8), Pugh (17), Windholz (23), Wyatt and Randall (24), and others.

MATERIAL STUDIED

During the period of this study 22 cases of monostotic fibrous dysplasia have been observed. Nine of these cases were proved by biopsy. In the remaining 13 cases no histopathological confirmation of the radiologic diagnosis was obtained, since biopsy or operation was not indicated clinically. Three additional cases were erroneously diagnosed as fibrous dysplasia. This analysis is based on the proved cases only.

CLINICAL MANIFESTATIONS

The clinical history is variable. In a number of cases the onset of symptoms was related to some specific trauma, in others a gradual onset without preceding trauma was recorded. In 5 of our series of proved

¹ Accepted for publication in April 1948

cases there was a history of a previous injury, usually not severe, incurred long enough (six months to two years) prior to diagnosis of the lesion to be of significance. In 2 cases the trauma occurred immediately prior to the radiologic examination at which the lesion was demonstrated. The remaining 2 cases gave a history of gradual onset of localized pain and swelling at the site of bone involvement. In one of the latter cases the symptoms were of several weeks duration while the other patient's complaints began ten months earlier. In none of these cases had an attempt been made to verify the presence or absence of bone injury roentgenologically, either at the time of the original trauma or subsequently, until the examination at which the lesion was revealed.

Persistent pain, though usually not severe, was noted in all of our proved cases of fibrous dysplasia. Four patients had a pathological fracture to account for the pain. Several of the unproved cases were asymptomatic. The next most common symptom was swelling, which was present in 3 cases, but in only one was the swelling of any considerable degree (Case 1). This patient showed the most extensive bone involvement, and the lesions were demonstrably progressive. Local tenderness occurred in only one case. No patient showed any of the extraskeletal manifestations commonly associated with polyostotic fibrous dysplasia (1). The period of observation was relatively short in the majority of cases, ranging from one month to twelve years. No patient showed leukocytosis, fever, or elevated sedimentation rate to suggest infection. The blood chemistry determinations were normal. The serology was negative.

ROENTGENOLOGIC ASPECTS

The roentgenographic features of fibrous dysplasia recur with sufficient frequency that, when observed, a probable diagnosis can be established. These features include (a) the site of the lesion, (b) new bone formation within the lesion, (c) the relation of the lesion to the surrounding

bone, (d) the occurrence of multiple lesions within a single bone, and (e) the ensuing deformity.

Lesions of fibrous dysplasia have been reported as occurring in practically every bone of the skeleton, though ribs and the long bones of the extremities are most frequently affected. The bones of the lower extremity are apparently a particularly favorite site of involvement. This was true of our cases, in which the lesions were limited to the lower extremities (Table I). The lesions within the bone are located in the metaphysis or diaphysis, the exact site presumably depending somewhat on the time interval from their development in the growing skeleton to their roentgenographic discovery. The epiphysis is probably never primarily affected by a fibrodysplastic bone lesion. Albright (2) states that he has never seen the epiphysis involved. Caffey (4) also, in his discussion of "bone cysts," lays stress upon their failure to extend into the epiphysis. A juxta-epiphyseal focus in the metaphysis may extend through a closed epiphyseal line, though in none of the cases in this series did this occur.

The area of involvement is characteristically sharply demarcated from the adjacent normal bone. The junction may show a zone of increased density, which is attributed by Sante (18) to compression of the cancellous structure. This is more frequently observed in the small solitary lesion than in the more extensive areas of involvement. The lesion is practically always eccentrically located and involves the cortex and the medulla, the former being encroached upon from its endosteal surface. Sante (18) stated that the point of origin is in the cortical layer, as indicated by the crescentic character of the involved area, with the base at the cortical margin, though the lesion may give the impression of being medullary in location when seen at right angles. Subperiosteal development of the lesions of polyostotic fibrous dysplasia has been reported (7). The larger lesions expand the cortex to a variable degree.

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- 6 Absence of periosteal reaction (except following a pathological fracture), penetration of the cortex, or soft-tissue invasion
- 7 A zone of increased density surrounding the area of involvement, especially evident in the smaller fully developed lesions
- 8 Normal density of uninvolved bone
- 9 Tendency to slow extension in childhood and non-progression in adults
- 10 Frequent occurrence of pathological fracture

(B) *Collaborative Criteria*

- 1 Characteristic occurrence in childhood or early adult life
- 2 Normal blood chemistry except for occasional slight elevation of the alkaline phosphatase
- 3 Absence of signs of inflammation or soft-tissue tumors in the overlying skin and subcutaneous tissues

DIFFERENTIAL DIAGNOSIS

While the criteria listed above are usually sufficient to permit a radiologic diagnosis of fibrous dysplasia, other bone lesions must frequently be considered in the differential diagnosis

(a) *Non-osteogenic fibroma* is identical with a smaller lesion of fibrous dysplasia except for the intrinsic "smudged" appearance produced by the metaplastic bone spicules in the latter

(b) *Solitary bone cysts* are characteristically located in the metaphyseal medulla, usually abutting on the cartilage plate of the epiphysis. The proximal end of the humerus, femur, or tibia is most frequently affected. The cysts produce bone rarefaction but no significant condensation of the surrounding bone. When they increase in size, they may expand the shaft and cause a thinning of the cortex. The intrinsic calcification accompanying fibrous dysplasia is absent

(c) *Enchondroma* occurs most commonly in the small bones of the hands and feet, an uncommon location for fibrous dysplasia

The shafts of the long bones are rarely involved. A few small points or blotches of calcification or ossification are sometimes present within the lesion proper (11), and help to differentiate it from fibrous dysplasia with its homogeneous increased density, though areas of calcification may be seen in some of the extensive fibrodysplastic lesions. Enchondroma tends to be centrally located in the medulla in contrast to the eccentric location of fibrous dysplasia.

(d) *Giant-cell tumor* can usually be differentiated by the following features: usual initial location in the epiphysis of a long bone, later age group (twenty to forty years), occurrence as a solitary tumor, greater expansion of the cortex, absence of calcification within the lesion proper, and response to irradiation.

(e) *Eosinophilic granuloma*, *Letterer-Siwe's disease*, and *Hand-Schüller-Christian disease* cause osteolytic lesions which are rarely demarcated by a sclerotic border (less than 10 per cent). The lesions may occasionally extend to involve the cortex and show periosteal reaction, but there is no intrinsic increased density ("smudge"). The bones of the leg, which are common sites of fibrous dysplasia, are usually spared by eosinophilic granuloma. This group of diseases occurs more frequently in males (7, 1). Obviously, the clinical features are of great importance whenever the reticulo-endothelioses are considered.

(f) *Neurofibromatosis* with bone involvement may closely simulate fibrous dysplasia, but the following points should be sufficient for differentiation: development of the osseous defect by erosion of the fibrous nodule from the periosteal surface into or through the cortex, the presence of the typical soft-tissue tumors in the skin or subcutaneous tissues, absence of calcification within the lesion, tendency to general distribution, and occasional involvement of the epiphyseal cartilage.

(g) *Chronic bone abscess* (Brodie's) may resemble the smaller lesions of fibrous dysplasia but can usually be differentiated by the absence of trabeculation within the lesion, little, if any, expansion of the cor-

tex, occasional presence of a sequestrum; zone of reaction or sclerosis around the lesion, occasional occurrence in the epiphysis, and usual medullary location

(h) The following are sufficiently rare or so unlikely to cause confusion that they deserve only passing mention in the differential diagnosis: angioma, epithelial inclusion cyst, adamantinoma, benign chondroblastoma, tuberous sclerosis, cystic tuberculosis, gumma, epidermoid, osteoid osteoma, lymphoblastoma, solitary myeloma, dyschondroplasia (Ollier's disease), and pyogenic or fungus infection of bone. Finally, in some cases the differential diagnosis cannot be made without biopsy and, occasionally, the diagnosis will remain in doubt even after this procedure.

PATHOLOGY

The characteristic gross and microscopic features of fibrous dysplasia as described by Lichtenstein and Jaffe (15) and by Schlumberger (20) were observed in all of the cases in this series. On gross examination the normal bone was replaced by fibrous tissue which showed the typical firm, rubbery consistency. On section, a characteristic gritty sensation resulting from the presence of minute spicules of metaplastic bone was noted. Some lesions contained tiny fluid-filled cysts, but in only one was there a true cyst of any considerable size. The cortex showed variable degrees of thinning but never to the point of complete disappearance. The pathological report in Case 3 described the presence of great amounts of whorled, interlacing fascicles of fibrous tissue which presented a benign appearance. Evenly distributed through this fibrous matrix were many histiocytes whose cytoplasm was replaced by a substance having the appearance of fat. The cells were greatly enlarged, the cell membrane was distended and the cytoplasm traversed by many fine fibrillae, giving the cytoplasm a lacy appearance. The nuclei were eccentric. The diagnosis was bone, fibula, fibrous dysplasia (Capt E F Alston). This diagnosis was concurred in by the Army Institute of Pathology. All

cases showed a similar basic appearance but with minor variations in the degree of cellularity and the amount of metaplastic bone spicule formation. A tendency to whorl formation was commonly noted. A few small giant cells were seen in some sections. Sections from three cases showed small areas containing a few foam cells. None showed areas of cartilage formation. The latter observation is of interest, since the presence of small areas of cartilage has been reported by some authors to be of not infrequent occurrence, though Schlumberger (20) found it only in those cases in which a pathological fracture had occurred.

CASE REPORT

CASE 1 A white male was first hospitalized in July 1934, at the age of six years, because of pain in the lower half of the left leg for six months and slight swelling of the same region for three months. He had fallen and sustained an injury to the leg a few months prior to onset of the pain. Roentgen examination at the first hospitalization revealed "several cystic areas in the left tibia" (Fig 1A). A diagnosis was made of fibrocystic disease of the bone, and surgical treatment was instituted, with unroofing of the lesions, curettage (no record is available of the histologic findings at that time), and application of phenol and alcohol to the involved areas. The wound healed promptly. Follow-up examinations indicated that the lesion was still progressing, and roentgen irradiation of the leg was started. The cervical region was also irradiated. Irradiation was given at intervals of three weeks for approximately two years (dosage unknown). The swelling remained, but there were no other symptoms until 1942, when the leg began to enlarge considerably just below the tibial tubercle and on the medial aspect of its mid portion. The patient experienced some pain, and there continued to be slow, progressive enlargement until admission to Brooke General Hospital in December 1946.

Physical examination revealed a fusiform enlargement of the upper and mid portion of the leg with the intervening part less enlarged. Roentgen examination showed anterior and medial bowing of the tibia with irregular expansion. There were numerous areas of decreased density in the cortex and medulla with increased density of the adjacent cortex and zones of increased density surrounding the individual "cystic" areas (Fig 1E). A few small lesions distal to the principal area of involvement showed soft-tissue density with no surrounding zone of increased density. The roentgenologic diagnosis was fibrous dysplasia. Skeletal survey showed no other lesions. Laboratory findings were as follows: blood count



Fig 1 Case 1 A Lesion in tibia at time of original admission, at six years of age Note cyst-like areas in bone with poorly defined margins eccentric location with cortical encroachment but no penetration, and beginning expansion B At age of seven years Note progression, with new lesions in spite of surgery and roentgen therapy, larger lesions show "smudge"

C Age nine years lesion progressing with increased deformity, note dense bone surrounding "cystic" areas D Age twelve years few new areas of involvement in distal diaphysis showing no dense border or "smudge", while adjacent older lesion shows both features, periosteum over proximal lesions thin but intact E Age eighteen years lesion more extensive, with increased deformity and expansion

TABLE I SUMMARY OF CLINICAL AND RADIOLOGIC FINDINGS IN CASES 2-9

History

Case No	Site of Lesion and Age of Patient	History	Local Findings	Ex-pan-sion	Tra-bection	Ho-mo-geneous Den-sity Smudge	Size	Patho-logical True-ture	Remarks
2	Proximal tibia 19 yr	Injury in jeep 'accident' knee examination of contused incidental lesion in tibia as symptoms No previous fracture incurred by jumping into ditch While piling blankets patient felt "sudden cracking" in lower leg followed by persistent local swelling Six months later, pathological fracture necessitating hospitalization Pain and swelling of both knees developed overseas Roentgen examination revealed lesion in tibia No history of injury Intermittent swelling and moderate pain in left knee for 10 months No preceding injury	None	No	Yes	No	1 5 X 2 5 cm	No	Evacuated from overseas with diagnosis of cyst, with diagnosis of bone
3	Proximal fibula 20 yr	No symptoms	Slight persistent swelling	Yes	Yes	Yes	2 5 X 4 cm	Yes	Evacuated from overseas with diagnosis of "cyst" of fibula See Fig 3
4	Proximal tibia 19 yr	No symptoms	Moderate swelling	Yes	Yes	Yes	4 X 5 5 cm	Yes	Skeletal survey showed no other lesions See Fig 4
5	Proximal tibia, 18 yr	Pain and swelling of both knees developed overseas Roentgen examination revealed lesion in tibia No history of injury Intermittent swelling and moderate pain in left knee for 10 months No preceding injury Patient received a bone bruise of right leg during a football game Tired aching feeling in leg for 5 months	None	Yes	Yes	Slt	1 X 3 cm	No	See Fig 5
6	Distal femur, 18 yr	Two years before admission patient received a bone bruise of right leg during a football game Tired aching feeling in leg for 5 months	Slight periarticular edema	Slt	Yes	No	2 X 3 cm	No	Evacuated from overseas with diagnosis of giant-cell tumor See Fig 6
7	Distal tibia 18 yr	None	None	No	Yes	Yes	2 5 X 3 cm	No	Skeletal survey showed no other lesions See Fig 7 Fig 8 shows microscopic appearance
8	Neck and proximal shaft of femur 24 yr	Patient struck hip against seat of plane 2 years before and was treated for "sprain" and was "bruised" hip 8 months before admission, this was followed by persistent dull ache Fracture of upper femur in 1943 Refracture at same site in 1943, metallic plate applied Moderate activity produced fracture site and patient was evacuated from overseas with diagnosis of giant-cell tumor	1 5" shortening of leg	Yes	Yes	No	3 X 6 cm	Yes	Diagnosis was confirmed by operation following transfer to another Army General Hos-pital
9	Proximal femur, 19 yr	Fracture of upper femur in 1943 Refracture at same site in 1943, metallic plate applied Moderate activity produced fracture site and patient was evacuated from overseas with diagnosis of giant-cell tumor	1 5" shortening of leg	Yes	Yes	No	3 X 6 cm	Yes	At operation one fairly large fluid-filled cyst was found, the remainder of the lesion consisted of typical fibrous dysplastic tissue

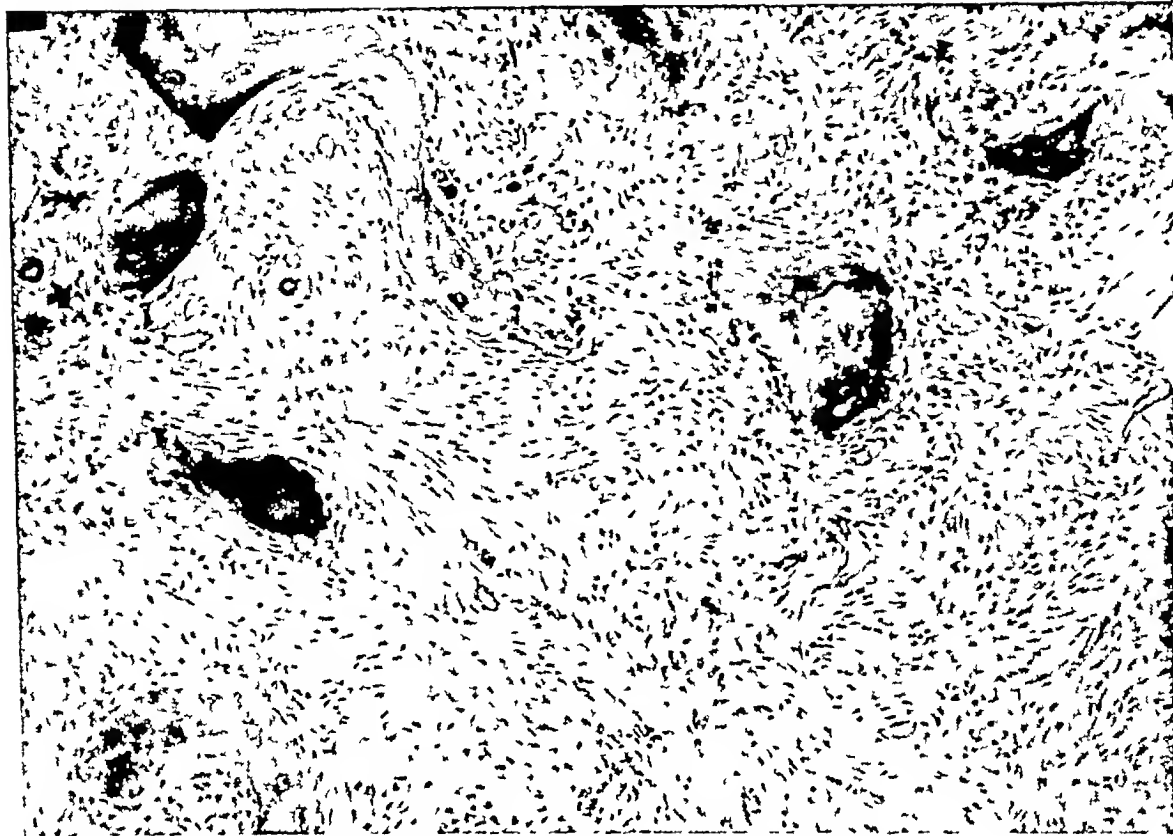


Fig 2 Case 1 Section from lesion in tibia showing typical fibrous tissue with minute bone spicules which give the lesion the "ground-glass" or "smudged" appearance $\times c 210$

and urinalysis within normal limits, serology negative, blood calcium 9.6 mg per cent, phosphorus 4.5 mg per cent, alkaline phosphatase 2.5 Bodansky units

In January 1947, a thorough curettage of all involved areas was performed, and the defective bone was reinforced by multiple bone grafts. Pathological examination of the removed tissue showed cancellous bone containing portions of yellow marrow replaced in some areas by irregular masses of grayish-white fibrocartilage-like tissue. Microscopic study (Fig 2) disclosed a relatively loose cellular fibrous tissue. The cells had a characteristic spindle shape, varied slightly in size and form, and exhibited oval to spindle shaped nuclei with faint condensations of chromatin and occasional nucleoli. Scattered throughout this fibrous tissue were numerous spicules of young bone showing prominent osteocytes and often surrounded by osteoblasts. The diagnosis was fibrous dysplasia of bone (Maj Lester S King). The diagnosis was concurred in by the Army Institute of Pathology.

Comment This case presented an opportunity to study the development of fibrous dysplasia during the period of skeletal growth. At the first examination (Fig

1A) there was no evidence of homogeneous increased density—"smudge"—but this appearance subsequently developed. The osseous proliferation on the medial surface to compensate for the weakened bone (Wolff's law) was also demonstrated. In the fully developed stage there were small, presumably young, lesions in the distal diaphysis which did not yet have the surrounding zone of increased density, suggesting that this feature is a later manifestation. The ineffectiveness of treatment in this case was demonstrated by progression in spite of surgery and irradiation.

The remaining cases are summarized in Table I.

DISCUSSION

The exact nature of the disorder underlying fibrous dysplasia remains unknown. Numerous theories of pathogenesis have been advanced. Lichtenstein and Jaffe (15) suggested a congenital defect of devel-



Fig 3 Case 3 Fibrous dysplasia in fibula Note expansion coarse columns of bone resembling trabeculation and pathological fracture

opment Thannhauser (22) considers the condition to be related to neurofibromatosis Schlumberger (20) saw the bone lesions as a possible result of disturbance of the normal reparative processes following bone injury Snapper (21) regards the process as a lipoid granuloma and stresses the presence of xanthoma cells in fresh lesions Hemorrhage into bone has also been postulated as a cause

The relation of trauma to the discovery of the lesion is obviously important, but the etiological relationship remains very questionable It would seem improbable that trauma is a fundamental factor in view of the rarity of development of the disease at the site of a bone injury where there has been roentgenographically demonstrable bone damage The development of new lesions in Case 1, after several years, in segments of the diaphysis nearer the epiphyseal line than the original site also

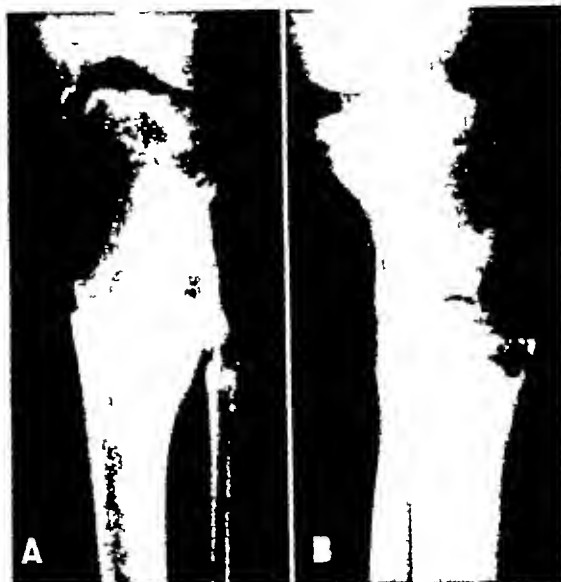


Fig 4 Case 4 Lesion in tibia A Note distinct border of increased density and 'smudged' appearance in lesion A pathological fracture has occurred and callus is present B Note eccentric location of lesion

argues against a traumatic etiology The tendency to attribute any abnormality to a previous injury is well recognized, and practically everyone has received sufficient traumata to be able to remember at least one for any part of the body that may be affected

The absence of any etiological relationship between fibrous dysplasia and hyperparathyroidism has been well established The recognition of the fundamental differences between these two conditions should prevent future needless exploration of the parathyroid glands

Cases of polyostotic fibrous dysplasia with extraskeletal involvement have been studied but are not included in this series Excellent discussions of this condition are given by Dockerty, Ghormley, Kennedy and Pugh (7), Albright (3), Jaffe (12), and others Its relation to monostotic involvement is the subject of some difference of opinion

The relation of fibrous dysplasia to bone cysts is of some importance Hodges, Phemister, and Brunschwig (9) consider that the fibrous tissue found in lesions of "osteitis fibrosa cystica localisata" develops following hemorrhage into true cysts

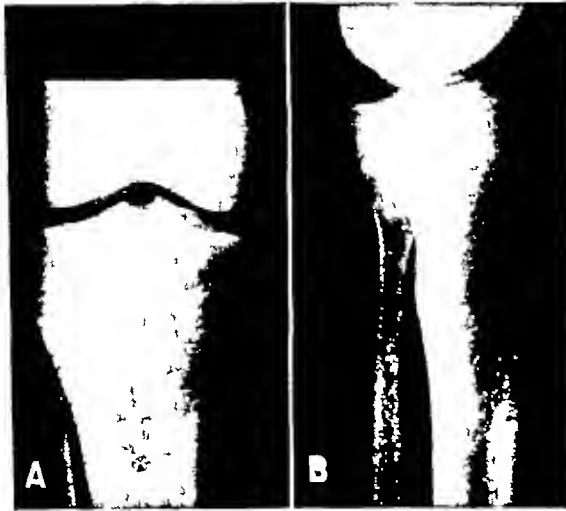


Fig 5 Case 5 A Small lesion of fibrous dysplasia in tibia resembling cyst. Border of increased density adds to sharp demarcation. B Note eccentric location, mainly involving the cortex. The periosteum and thin layer of cortical bone adjacent to it are intact.

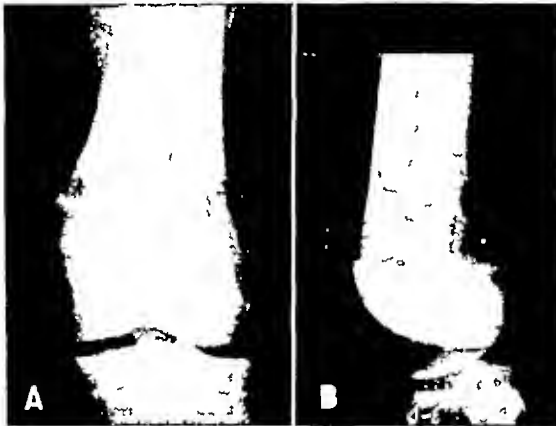


Fig 6 Case 6 A Solitary lesion in femur. Coarse columns of bone bordering the areas of fibrous tissue give a trabeculated appearance. B Lateral view suggests central location but Fig 6A shows typical eccentric location. The border of the lesion is narrow but fairly dense.

Lichtenstein and Jaffe (15), on the other hand, are of the opinion that the characteristic fibrous tissue which fills these cyst-like lesions is the primary constituent, while the small true cysts occasionally found at operation represent focal degeneration in this fibrous tissue. In this series of cases there were only two in which true cyst development could be demonstrated, and in these the fibrous tissue constituted the major portion of the lesion.

The location of the lesions is fairly char-

acteristic. In this group there were 3 in the femur (1 in the proximal metaphysis, 1 in the proximal diaphysis, and 1 in the distal diaphysis), 5 in the tibia (4 in the proximal metaphysis or diaphysis and 1 in the distal diaphysis), and 1 in the proximal diaphysis of the fibula. The unproved cases showed lesions in the femur in 3 instances, in the tibia in 6, in the fibula in 2, in the humerus in 1, and in the ischium in 1.



Fig 7 Case 7 Sharply demarcated lesion in tibia. Biopsy showed fibrous tissue with minute bone spicules (Fig 8).

The reliability of the roentgenologic diagnosis of fibrous dysplasia can be estimated from the following analysis of this series:

- 25 cases roentgenologically diagnosed fibrous dysplasia
- 13 cases not biopsied
- 12 cases biopsied
- 9 cases confirmed
- 3 cases in error

During this period there has been no instance of error in roentgenologic diagnosis of cases which have proved to be fibrous dysplasia on histologic examination. This analysis of proved cases makes it probable that the error will not exceed 25 per cent.

The cases which were erroneously diagnosed as fibrous dysplasia proved, on biopsy, to be eosinophilic granuloma (1 case), giant-cell tumor (1 case), and unicameral bone cyst (1 case). These lesions

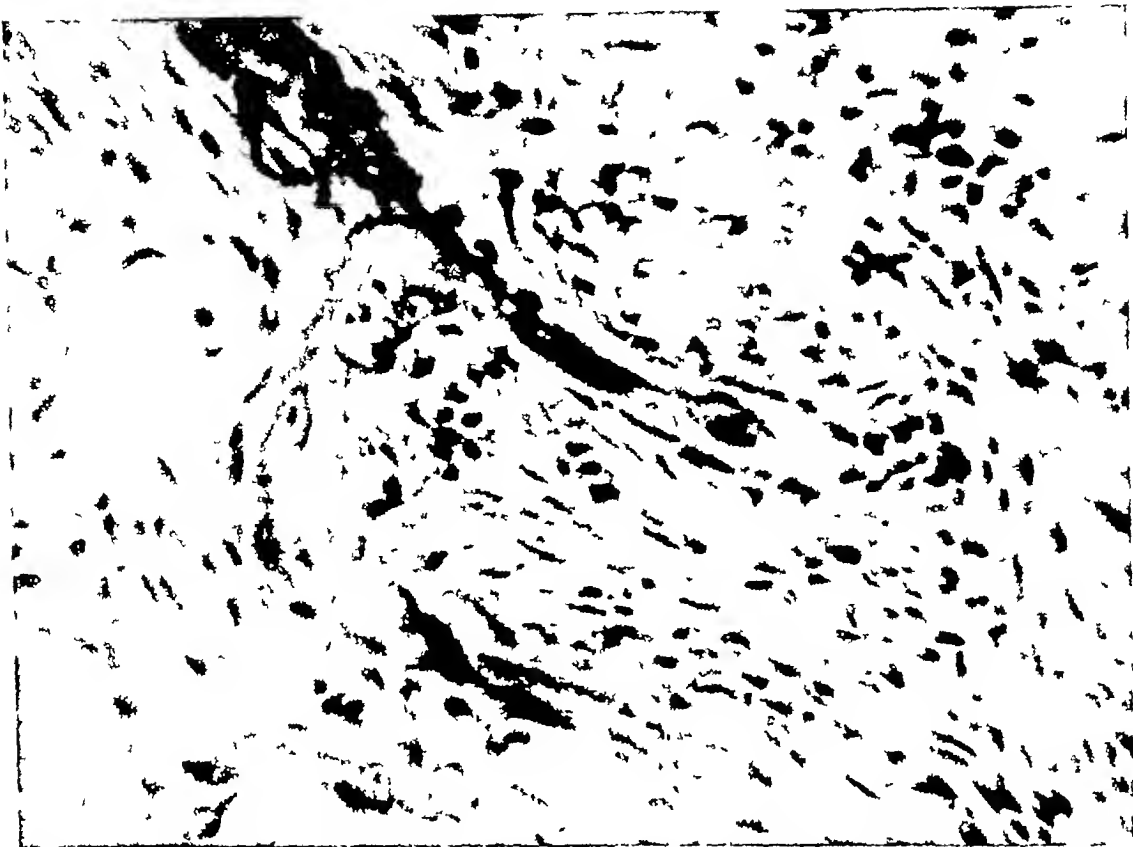


Fig 8 Case 7 Section from lesion shown in Fig 7 Minute bone spicules are scattered throughout the fibrous tissue X c 525

did not show the typical roentgenographic appearance of fibrous dysplasia

The lesion was progressive in Case 1, but no other case in this series showed any change in size or appearance during the period of observation except as a result of fracture or surgery. This suggests that the progressive tendency occurs only during the period of active skeletal growth.

The prognosis is good in that the condition tends to be self-limited. Most authors state that malignant degeneration is not known to occur, but Coley and Stewart (6) report 2 cases of polyostotic fibrous dysplasia in adults with subsequent development of sarcoma, and Camp (5) reports 1 such case. Occasional spontaneous healing has been reported, but no evidence of such has been seen in this series.

Treatment is indicated in those cases which are definitely symptomatic and in cases where the lesion is located in a position where pathological fracture is probable

or has repeatedly occurred. Simple excision or curettage and bone graft are usually adequate in the adult. Recurrence was noted in only one case in this series (Case 1) and that was during childhood. Irradiation is generally considered not to be effective in controlling the lesion. This was true in the one case in this series (Case 1) which was irradiated.

SUMMARY AND CONCLUSIONS

The clinical, roentgenologic, and pathologic aspects of monostotic fibrous dysplasia are presented, with specific findings in 9 cases which have been confirmed by operation and histologic study at Brooke General Hospital during the two-year period 1946-47. Brief comment is also made regarding 13 unconfirmed cases with a characteristic roentgen picture seen at that hospital during the same period.

The roentgenographic appearance of the majority of lesions of fibrous dysplasia is

characteristic. The diagnostic features most frequently observed include a sharply demarcated area of decreased density resembling a cyst, a homogeneous increase in density within the lesion, giving a "smudged" appearance, a zone of increased density surrounding the smaller lesions, and eccentric location in the diaphysis or metaphysis of a long bone.

Atypical lesions cannot be unequivocally identified by the roentgen and clinical findings and must be diagnosed by biopsy.

The lesions of fibrous dysplasia tend to be progressive during the period of active skeletal growth and stationary during adult life.

Conditions to be differentiated from fibrous dysplasia are non-osteogenic fibroma, solitary bone cyst, enchondroma, giant-cell tumor, eosinophilic granuloma, Letterer-Siwe's disease, and Hand-Schüller Christian disease, neurofibromatosis, and chronic bone abscess (Brodie's abscess).

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(For Spanish Summary see following page)

SUMARIO

Displasia Fibrosa del Hueso (Monosteótica)

Al exponer los aspectos clínico, roentgenológico y patológico de la displasia fibrosa monosteótica, preséntanse los hallazgos específicos en 9 casos confirmados por la operación y el estudio histológico. También se ofrecen breves comentarios acerca de otros 13 casos no confirmados, pero con típico cuadro radiológico.

El aspecto radiográfico de la mayoría de las lesiones de la displasia fibrosa es típico. Los rasgos diacríticos observados más a menudo comprenden una zona netamente demarcada de menor densidad que semeja un quiste, aumento homogéneo de la densidad en el interior de la lesión, creando un aspecto "tiznado", una zona de mayor densidad que circunda las lesiones más pequeñas, y localización excéntrica en la

diáfisis o metáfisis de un hueso largo. Las lesiones atípicas no pueden ser inequívocamente identificadas por los hallazgos radiográficos y clínicos, temiendo que ser diagnosticadas por la biopsia.

Las lesiones de la displasia fibrosa suelen ser progresivas durante el período de desarrollo activo del esqueleto y estacionarias durante la vida adulta.

Estados que hay que diferenciar de la displasia fibrosa son fibroma anosteógeno, quiste óseo solitario, encondroma, tumor gigantocelular, granuloma eosinofílico, enfermedad de Letterer-Siwe y enfermedad de Hand-Schuller-Christian, neurofibromatosis, absceso óseo crónico (absceso de Brodie).



Parotid Tumors

A Review of Ninety-Three Cases¹

MARCUS J SMITH, M D, and K. WILHELM STENSTROM, Ph.D

THE TREATMENT of a parotid tumor is primarily a surgical problem. Radiation therapy may, however, be required either in combination with surgery or because in a given case it is the only suitable method. In order to obtain some information concerning the results of such therapy, the records of all the patients referred to the radiation therapy section at the University of Minnesota Hospitals between 1927 and 1947 for treatment of parotid tumors were reviewed. A brief discussion of the disease and the 93 cases constituting this series is here presented.

Any attempt to evaluate the results of treatment of parotid tumors is rendered difficult by the pathology, pathogenesis, and clinical course of the mixed tumors which constitute a large percentage of parotid neoplasms. These tumors present a most bizarre and variable pathologic picture, and a great number of histologic classifications have appeared in the literature. We have abided by the decision of the Department of Pathology of the University of Minnesota Hospitals, and classified parotid tumors in two main groups: mixed tumors and carcinomas (adenocarcinoma, cylindroma, undifferentiated carcinoma, etc.).

Briefly, two theories of origin of mixed tumors are considered at the present time (37): the single-tissue origin, from epithelium of salivary or mucous glands or from detached salivary gland anlage, and the dual tissue origin, from branchial cleft inclusions or embryonal non-branchial anlage (ectoderm and mesenchyme). Probably the former theory is now the most acceptable, particularly since the demonstration by Fry (14) that cartilage found in mixed tumors is really simulated cartilage, and epithelial in origin. This was also

demonstrated by Allen (2). This is of importance, from our point of view, only in so far as radiosensitivity is concerned. Differences in pathogenesis may be responsible for variations in radiosensitivity. The more embryonal the tissue, the more sensitive to radiation we may expect it to be.

No reports of parotid tumors have been found in which any etiologic significance was attributed to trauma, although Fraser (13) claimed to have produced such tumors in animals by traumatizing the ductal epithelium. Infections and calculi do not seem to play an important role in the development of these tumors.

Mixed tumors contain epithelium, cartilage, lymphoid tissue, and connective tissue, this last showing evidence of mucin production (5, 8). The nature of these tumors, *i e.*, whether malignant or benign, has been a matter of controversy. Ahlbom (1) recognized benign and malignant subdivisions, based on microscopic appearance. Some authors have been of the opinion that mixed tumors are benign (6, 15, 30, 34). Merritt (27) referred to them as "mildly malignant". Fry (14) could find no definite dividing line between innocent and malignant, and Dixon and Benson (12) stated that "most pathologists agree that mixed tumors of the parotid gland are almost invariably malignant". Levin (19) believed that the mixed tumor represents a malignant transformation of a teratoma, while Krompecher (17) felt that all mixed tumors were basal-cell carcinomas. McFarland (26) based his opinion on Ewing's six criteria of malignancy:

- (1) Infiltrative growth. Mixed tumors do infiltrate if their capsules are opened.

¹ From the Department of Radiology and Physical Therapy of the University of Minnesota and the University Hospitals, Minneapolis, Minn. Accepted for publication in March 1948.

- (2) Local tissue destruction Rarely associated with mixed tumors
- (3) Recurrence after removal A chief characteristic of mixed tumors
- (4) Metastases Rarely associated with mixed tumors However, metastases have occasionally been reported (20, 31) Mulligan (28) reviewed 22 such cases and added 20 new ones He concluded that metastasis occurs more often than is generally assumed
- (5) Local interference with function Mixed tumors occasionally cause restricted jaw motion, deafness, seventh nerve palsy, rarely fifth nerve pain, and more rarely still, cystic dilatation of the parotid gland
- (6) General toxic action of absorbed tumor products Not found with mixed tumors

In view of these facts, McFarland (24) concluded that "mixed tumors do not, therefore, become malignant, rather they are malignant, though this is true in varying degrees in different cases"

Adenocarcinoma, cylindroma, and squamous-cell carcinoma arise from glandular, basal-cell (32), and squamous-cell tissue The carcinomas are difficult to influence by radiation and the results of treatment have, as a rule, been unsatisfactory

The first successful treatment by radiation of a malignant parotid tumor was reported in 1909, by Wickham and Degrais (38), who used surface radium Since then numerous case studies have appeared in the literature Particularly notable are the reports of McFarland (24-26) and Ahlbom (1) For a more complete review of the historical aspects of parotid tumors, the reader is referred to the article of Utendorfer (37)

MIXED TUMORS

Our series included 58 mixed tumors Of these, 45 were confirmed pathologically, no pathologic reports were available for the other 13 Statistics as to recurrence will include only the proved cases The patho-

logic findings are based on study of the surgical specimens, biopsies were not taken This is in conformance with the accepted belief that biopsy causes rupture of the tumor capsule and danger of dissemination (24, 37)

Among 65,351 hospital admissions, T M Martin (23) found 34 mixed parotid tumors, an incidence of 0.05 per cent These tumors may occur at any age and have been reported (16) as early in life as seven months and as late as eighty years The most frequent age of appearance is in the third decade, with about equal division among the sexes, and without evidence of preference as to side of involvement (16, 19, 22, 37)

The 58 mixed tumors reported here represent 63 per cent of our series of parotid tumors The age range was from thirteen to seventy-two years, the average being 39.7 years at the time of treatment Nineteen patients were males (33 per cent) In 26 cases the right side was involved (45 per cent) All patients were of the white race, but because of the small Negro population in Minnesota this is not significant

Characteristic clinical findings were a firm nodule in the parotid region, progressing very slowly in size over a period of many years It was usually painless, although mild aching or pain was occasionally present The non-tender mass was attached to the underlying gland, but was usually not adherent to the skin Occasional manifestations were involvement of the seventh nerve by large tumors and recent increase in size before treatment was requested The tumors ranged in size from 1×1.5 cm to 10×15 cm, the average diameter being 2.6 cm in 44 cases in which the original size was recorded The duration of the tumor before treatment at the University Hospitals ranged from three months to twenty-five years and averaged 5.5 years Stein and Geschickter (34) gave the average duration as four years and Hawk and Shepherd (16) as eight years Ten patients had received surgical treatment elsewhere two to twenty

years before being treated at the University Hospitals

Combinations of surgery, x-rays, and radium were used in the treatment of mixed tumors (Table I). Some cases, not included in this report, were treated by surgery alone. The surgical procedure consisted of enucleation or curettement. Total parotidectomy, a relatively recent surgical approach (3, 4, 36), was not used. The x-ray therapy factors in general were 200 or 220 kv, 15 or 30 ma, 0.5 mm Cu filter, 60 cm distance. The dose was 1,200 to 1,500 r/air to each of three fields, over the parotid region—anterior oblique, posterior oblique, and lateral. Field sizes averaged about 8×10 cm, and the treatment time per case ranged from two to four weeks. Radium therapy was given in the form of radon seeds implanted into the tumor bed, 1 to 1.5 mc gold (0.3 mm) implants were used, and dosages ranged from 700 to 2,000 mc hr, depending on the size and distribution of the lesion. All therapy was postoperative except for recurrences, which were usually treated with radiation alone.

It is generally agreed that five-year survival rates are meaningless in assessing results of treatment for mixed tumors. Most observers use recurrence rate as the yardstick and agree that these tumors may recur many years after treatment.

Table I shows the results in our series of patients treated between 1927 and 1937, with a ten- to twenty-year follow-up. Thirty-three cases of the entire group of 58 mixed tumors were first treated during that period.

The 7 tumors that recurred were all retreated one, one, two, four, four, five, and eleven years after the original therapy. Two of these recurred again five and twelve years after original therapy and were again retreated. Only one tumor recurred a third time and was retreated nine years after the first treatment. Of the 7 patients with recurrences, 5 are well without further recurrence twelve, ten, nine, eight, and four years after the final treatment.

TABLE I RESULTS OF TREATMENT OF MIXED TUMORS, 1927-37

Type of Treatment	Cases	Fol- lowed Less Than 10 Years	Fol- lowed More Than 10 Years	Recurrences of Cases Followed More Than 10 Years
Surgery and x-ray	18	5	13	4
Surgery, x-ray, and radium	12	1	11	2
Surgery and radium	2	1	1	0
X-ray alone	1	0	1	1
TOTAL	33	7	26	7 (30%)

The percentage of recurrence after surgical treatment alone has been reported (6, 26, 30, 34, 35) as varying between 15 and 100 per cent. Ahlbom's (1) recurrence rate for 120 patients is considerably lower. By using preoperative roentgen irradiation or telerradium and postoperative interstitial radium therapy, he reduced the five-year recurrence rate to 6 per cent. This is probably the lowest figure reported for a good-sized series. Older reports in the literature reject irradiation as valueless (6, 11, 16, 23), while recent papers tend to favor it in combination with surgery as the preferred treatment, particularly postoperative x-ray therapy (15, 19, 27, 29). Perhaps this is because of the improvement in irradiation techniques during the past twenty years.

That statistics concerning recurrence rates are open to question was well demonstrated by McFarland (26). He pointed out that his own rate of 25 per cent included cases lost to follow-up and cases observed less than five years. When he excluded these cases, his recurrence rate (surgery alone) rose to 62 per cent!

McFarland (24) also pointed out that small tumors were more apt to recur following removal than large tumors, probably because of multicentric origin and eventual fusion of small lobules into one large encapsulated mass. Therefore, he deplored haste in surgery and preferred waiting until the tumor enlarged. Our own observations did not confirm this finding, for recurrences were found in tumors of all sizes—from 1 to 9 cm in diameter.

TABLE II TWENTY-SIX CASES OF PROVED CARCINOMA OF THE PAROTID GLAND

Year*	No of Cases	Years of Survival										Living
		1	2	3	4	5	6	7	8	9	10	
1931	2	2	1	1	0	0	0	0	0	0	0	0
1932	2	2	2	1	1	1	1	1	1	1	1	1 June 1946
1933	1	1	1	0	0	0	0	0	0	0	0	0
1934	3	1	0	0	0	0	0	0	0	0	0	0
1935	2	1	1	1	1	1	1	1	1	1	0	? Alive July 1944
1936	1	1	1	1	0	0	0	0	0	0	0	0
1938	3	2	2	2	1	1	1	0	0	0	0	0
1940	1	1	1	1	1	1	1	1				1 May 1947
1943	1	1	1	1	1							1 February 1947
1944	3	3	3	2								2 April 1947, January, 1948
1945	2	2	2									2 October 1947 (both)
1946	5	4										4 June, September, October 1947 (2)
Cases	26	26	21	19	16	15	15	15	14	11	11	
Survival		21	15	10	5	4	4	3	2	2	1	
Per cent		81	72	52	31	27						

* No cases reported in 1937 1939, 1941 1942

Treatment was followed by undesirable complications in 14 of our cases. In 5 there was transient seventh nerve palsy and in 2 permanent palsy postoperatively. Four patients had skin changes over the areas of irradiation, consisting of skin atrophy and telangiectasia, and 2 patients had induration, though not of severe grade. In 1 patient, exposed to multiple episodes of surgery, radium, and roentgen therapy severe ulceration and bleeding developed necessitating prolonged hospitalization and skin grafting. There were no instances of salivary fistula.

Deaths were attributable in 3 cases to causes other than parotid mixed tumor—tuberculosis, carcinoma of the stomach, and cerebral thrombosis. The cause of death in one case is unknown. There were no proved metastases in our group.

CARCINOMA

Thirty-five cases of carcinoma of the parotid gland were observed. The pathologic specimens were not available for review in 9 instances. In these 9 cases the diagnosis had been made originally from the clinical features and had never been confirmed by biopsy. In this group, the disease was far advanced at the time of first observation and the diagnoses were based primarily on the site of the primary lesion and the symptoms and physical findings, including lymph node metastases.

Of the total group, 26 were histologically malignant, ranging from cylindroma to frank carcinoma, there were 2 proved squamous-cell carcinomas originating in the parotid gland. Only the 26 cases proved by biopsy, examination of the surgical specimen, or of an involved lymph node, are included in determining the end-results (Table II).

The average age of the patients with carcinoma was 63.3 years (range was from thirty-seven to eighty-three years). Fourteen patients were males. All were white.

Clinically, these cases were characterized by tender, hard masses in the parotid region which enlarged rapidly, showing marked local invasive tendencies. Usually the tumors were adherent to the skin and underlying tissues, often the masses were ulcerated and fungating. Severe pain was common, seventh nerve involvement and fifth nerve neuralgia were not unusual. Interference with jaw function was occasionally seen. Metastases to cervical nodes were present on admission in 12 cases (including 3 in the clinical group), pulmonary metastases were present in 2 cases and osteoblastic metastases in the pelvis and spine were present in 2 cases (not verified postmortem). There were some cases in which the presenting clinical picture resembled that of mixed tumors, and microscopic sections had to be studied in order to make the diagnosis.

One of the striking clinical features was the long duration of the parotid tumor before it had begun to enlarge rapidly. In 13 cases there was a history of ten or more years. Three tumors had been present thirty years or longer, one for thirty-eight years. No doubt these had been regarded as mixed tumors and left untreated (by choice or neglect) until they began to enlarge, usually a few months to a year before being referred for treatment. Six cases had received previous surgery.

Treatment was similar to that for mixed tumors, but more intensive. Surgery consisted of excision, including one total parotidectomy and two radical neck dissections. For x-ray therapy the same factors were utilized as for mixed tumors except that the doses ranged from 1,200 to 1,800 r/air and the fields were larger and included the cervical lymph channels and nodes. Radon seeds were inserted postoperatively or as an independent procedure, in doses similar to those for mixed tumors. Excision, radon insertion, and postoperative x-ray irradiation, followed by a second and third course of x-ray and interstitial radiation therapy, was the rule rather than the exception. Inoperable cases and recurrent cases were treated by irradiation alone, and fair to good palliation was obtained, judged by relief of pain, improvement of jaw function, and decrease in the size of the mass.

Results in terms of five-year survivals were poor. In the unproved group there were 8 deaths, 2 of the patients surviving five and six years before succumbing to the disease. One patient is alive two years after treatment, but not free from carcinoma. In the total group there were 18 deaths and 3 cases were untraced. Of the 26 proved cases (Table II), 11 were treated too recently for five-year follow-up. Among the 15 cases followed for five years or longer, there were 4 five-year survivals (27 per cent). One patient died of disease during the sixth year of follow-up, one is alive and probably free from cancer during the fourteenth year (a lump is present in the gum, but without increase in size for

three years), and one was free from disease after nine years.

Benedict and Meigs' (6) mortality in 30 proved cases of parotid gland carcinoma was 96.7 per cent. MacFee (21) reported 3 out of 27 patients (11 per cent) surviving after five years. In a series of 20 cylindromas, Quattlebaum, Dockerty, and Mayo (32) reported 8 deaths from metastases in five years, 2 deaths after five years, and 4 inoperable recurrences. Ahlbom (1), using teleradium or x-rays preoperatively or postoperatively, or radiotherapy alone for inoperable and radiosensitive operable lesions, obtained a 25 per cent five-year survival in 82 malignant parotid gland tumors. Cade (10), using preoperative irradiation, had 5 of 14 patients alive without disease after five years.

Poor results can possibly be correlated with the failure of the patient to report for early treatment. They can be blamed partially on a widespread belief that haste in treatment of mixed tumors is not necessary. Since biopsies are taboo in mixed tumors and since it is often difficult to distinguish between a mixed tumor and carcinoma, it seems advisable to urge operative removal, subsequent radiation, and microscopic study as soon as possible after detection of the tumor in order to avoid the poor results obtained in the treatment of carcinomatous parotid tumors that have been dormant for many years. Perhaps preoperative irradiation should be added to the armamentarium. Ahlbom's results, using that method, are better than average. Should the tumor turn out to be a mixed tumor, no harm has been done, for some observers feel that preoperative irradiation simplifies surgery for mixed tumors by making the capsule firmer and easier to remove (1, 10, 34).

CONCLUSIONS AND SUMMARY

1. Ninety-three cases of parotid tumor are reviewed. 58 mixed tumors and 35 carcinomas.

2. The pathogenesis of mixed tumors is reviewed briefly.

3. Mixed tumors should not be con-

sidered unqualifiedly as benign tumors, but rather should be thought of as potentially, if not actually, malignant

4 The high recurrence rate of mixed parotid tumors indicates that surgery and irradiation should be used in combination for treatment of these growths unless the tumor is encapsulated and a complete parotidectomy can be performed. The recurrence rate for 33 patients followed for ten years or more in the present series was 30 per cent

5 The value of radiation therapy for recurrences of mixed tumors is emphasized by the fact that 5 of the 7 patients with recurrent tumors were at the last examination following such retreatment free from any symptoms

6 Procrastination in treatment is not recommended, since biopsies are condemned, and differential diagnosis between mixed tumor and carcinoma often depends on the microscopic findings in the surgical specimen

7 Even with the use of radical surgery and postoperative irradiation, the five-year survival rate in carcinoma was only 27 per cent

8 Many carcinomas had histories of lengthy duration (up to thirty-eight years). Earlier treatment seems advisable

9 Radiation alone is valuable for recurrent and inoperable carcinomas

NOTE We wish to thank Dr Robert Hebbel for reviewing the pathologic material

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SUMARIO

Tumores de la Paróidha Repaso de 93 Casos

La serie comunicada comprende 93 tumores de la paróidha (58 mixtos y 35 carcinomas), tratados ya con la radioterapia sola o combinada con la cirugía

Los tumores mixtos no deben considerarse incondicionalmente como benignos, sino más bien como potencial o realmente malignos Debido a su elevado coeficiente de recurrencias, deben ser tratados, a menos que estén encapsulados y pueda ejecutarse una parotidectomía total, con una combinación de cirugía e irradiación En esta serie, la cirugía consistió en la enucleación o el raspado, y la irradiación postoperatoria comprendió rayos X, implante de semillas de radón o ambos Entre 26 casos comprobados y mantenidos en observación durante diez a veinte años hubo 7 recurrencias (30 por ciento) después del tratamiento primitivo El valor de la irradiación en las lesiones recurrentes queda indicado por el hecho de que 5 de estos 7 enfermos estaban sin síntomas en el último examen, de cuatro a once años después de repetirse el tratamiento

El tratamiento en el carcinoma fué seme-

jante al empleado en los tumores mixtos, pero más intenso La cirugía consistió en la excisión, incluso una parotidectomía y dos disecciones radicales del cuello La dosis de radiación fué ligeramente mayor que en los tumores mixtos y los campos también mayores, comprendiendo los conductos y ganglios linfáticos cervicales En 15 casos comprobados el coeficiente de sobrevivencias de cinco años fué de 27 por ciento Uno de los 4 enfermos que vivió cinco años murió de la enfermedad en el sexto año

No se recomienda la demora en el tratamiento de los tumores paróidos, dado que las biopsias están contraindicadas y la diferenciación entre tumor mixto y carcinoma se basa a menudo en el estudio microscópico del ejemplar extirpado Muchos carcinomas muestran una historia larga antes de aparecer rápidamente la hiperplasia que lleva al enfermo a consultar al médico, en 13 casos de esta serie había habido un tumor diez años o más y en 3, treinta años o más

En el carcinoma recurrente e inoperable la irradiación sola posee valor paliativo

Cavitary Form of Pulmonary Neoplasm¹

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A LARGE AMOUNT of literature has been accumulating in recent years on the subject of pulmonary cancer. Early diagnosis has been constantly stressed, in view of the remarkable strides in thoracic surgery and the consequently more hopeful outlook if surgery is undertaken sufficiently early.

To arrive at an early diagnosis, one of the most important steps is the roentgenologic study. Various procedures, including bronchography and body-section roentgenography, have been advocated and employed in addition to the conventional chest films. The fact remains, however, that no specific roentgen signs of pulmonary cancer exist. As far as can be determined—both from personal experience and perusal of a voluminous literature—there is no roentgenologic method by which early bronchogenic carcinoma can be reliably differentiated from pulmonary infection. Bronchoscopy with biopsy is still the only means by which a positive diagnosis can be made before metastatic lesions are discovered, unless exploratory thoracotomy is performed.

Negative bronchoscopic results, however, do not rule out the existence of pulmonary cancer, especially if the lesion is located peripherally or in one of the upper lobes. To differentiate between an infectious process and a malignant neoplasm in such cases, it may be necessary to resort to serial roentgenograms, which may mean weeks, and often months, of delay, although the finding of tumor cells in the sputum by special staining methods holds great promise as an early diagnostic aid.

The type of malignant pulmonary lesion most often confused with infection is the

cavitary form of bronchogenic carcinoma. Holman and Pierson (1) point out that "carcinoma may simulate suppuration so closely that neither the clinician nor the radiologist can determine the exact nature of the disease." Others, including Kirklin and Paterson (2) and Howes and Schenk (3) refer to the same difficulty. Yet we have made considerable progress since Fishberg and Rubin (4) wrote, in 1929, that while they had seen many references in the literature to this type of neoplasm, few clinicians had recognized it during the patient's lifetime. A decade later, Hauser and Wolpaw (5) reported 15 cases of cavitary bronchogenic carcinoma, in 10, or two-thirds, of which a correct diagnosis was made. In 6 of these cases the diagnosis was established by bronchoscopy, in 3 others by biopsy and thoracotomy. In one case no diagnosis could be established by any method and it was arrived at on the basis of the clinical course. Gottlieb and Sharlin (6) on the other hand, describe 2 cases in which the history, clinical picture, and roentgen appearance all suggested neoplasm, but which proved on serial roentgenography to be lung abscesses.

The frequency with which the cavitary form of bronchogenic carcinoma occurs in autopsy material is given by Hauser and Wolpaw as varying with different observers from 12 to almost 50 per cent. Fishberg and Rubin found it in 30 per cent of their cases.

The type of tumor which, in the light of experience at this hospital, most often undergoes cavitation is the more or less circumscribed, rounded mass, that is, the peripheral type of bronchogenic carcinoma rather than the infiltrating, stenosing,

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main bronchus tumor. In the former, the blood supply to the central or deeper portions of the mass eventually becomes cut off, with resultant necrosis. This may be said to be true of all rapidly growing tumors, yet we have observed cavitation in a tumor less than 4 cm in diameter. Furthermore, Fishberg and Rubin point out that cavitation occurs almost exclusively in primary tumors. Even large metastatic masses in the lung can be observed for months without breaking down. Hauser and Wolpaw explain the excavation as often due to aseptic necrosis, resulting from occlusion of the smaller blood vessels in and around the neoplasm by tumor thrombi. In addition, infection undoubtedly plays an important role. It would appear that compression of the smaller bronchi within the tumor takes place first, with bronchiectasia distal to the compression. This leads to accumulation of secretions, infection, and finally necrosis. It is probable that a combination of both factors, changes in the blood supply and infection, are responsible for the necrotizing process in the majority of cases.

DIAGNOSIS

There is no characteristic clinical picture by which cavitary pulmonary neoplasm—or, indeed, any form of pulmonary cancer—can be recognized. It is axiomatic in medical diagnosis that often the correct interpretation may be missed simply because the possibility has not been considered. The history, clinical picture, and, above all, the patient's age should direct attention to the possibility of a malignant lesion. Cough, hemoptysis, or blood-streaked sputum, and weight loss are almost always present. Chest pain is a common symptom, and there is often a low-grade fever. Dyspnea, somewhat out of proportion to the pulmonary changes, is seen in many cases. There may be hyperesthesia of the skin on the side of the chest where the lesion is located (4). When any combination of these symptoms is present in a patient over forty years of age, neoplasm should be considered until disproved.

Roentgenologically, the lesion often presents a rather well circumscribed, round, or ovoid appearance, suggesting an infected fluid cyst or, when small, a tuberculoma. At other times the infiltration is more diffuse, simulating pulmonary abscess or ulcerating tuberculosis. The cavity is often eccentric, and the contours of the inner wall have an irregular, ragged, or "bumpy" appearance, corresponding to the irregular tissue necrosis within the tumor. This is especially well brought out by body-section roentgenography. In the conventional chest film a large portion of the inner wall may be obscured by the fluid within the cavity. In the planigram, however, the fluid gravitates into the posterior recess of the cavity and, anterior to this, the whole circumference of the cavity wall is well demonstrated. A chest film with the Bucky diaphragm, even with the patient supine, will not accomplish the same results, because of the summation of shadows lying in the same sagittal planes.

We should like to emphasize this irregular, "bumpy" character of the cavity wall in neoplastic disease. It has been described often before (4, 5, 7-9). It is not claimed to be a pathognomonic sign of cancer, it may be found at times in other conditions, especially in tuberculosis. It should be stressed, however, that its occurrence is frequent in malignant disease, and, when recognized, it will direct early attention to the true nature of the lesion.

In 3 of the 5 cases presented here the diagnosis was suggested by the appearance of the cavity, in the fourth the diagnosis was quite obvious because of the destructive rib lesions. In one case the diagnosis was not made during the lifetime of the patient.

CASE REPORTS

CASE I (Fig 1) A 54-year-old white male was admitted to this hospital on June 26, 1947, complaining of fatigue, chronic cough productive of a copious greenish-yellow sputum, foul breath, and a weight loss of 30 pounds within the past month. He had pneumonia in the left chest six months previously, for which he was treated at home with penicillin and sulfa drugs. He returned to work after four weeks but continued to cough, and the

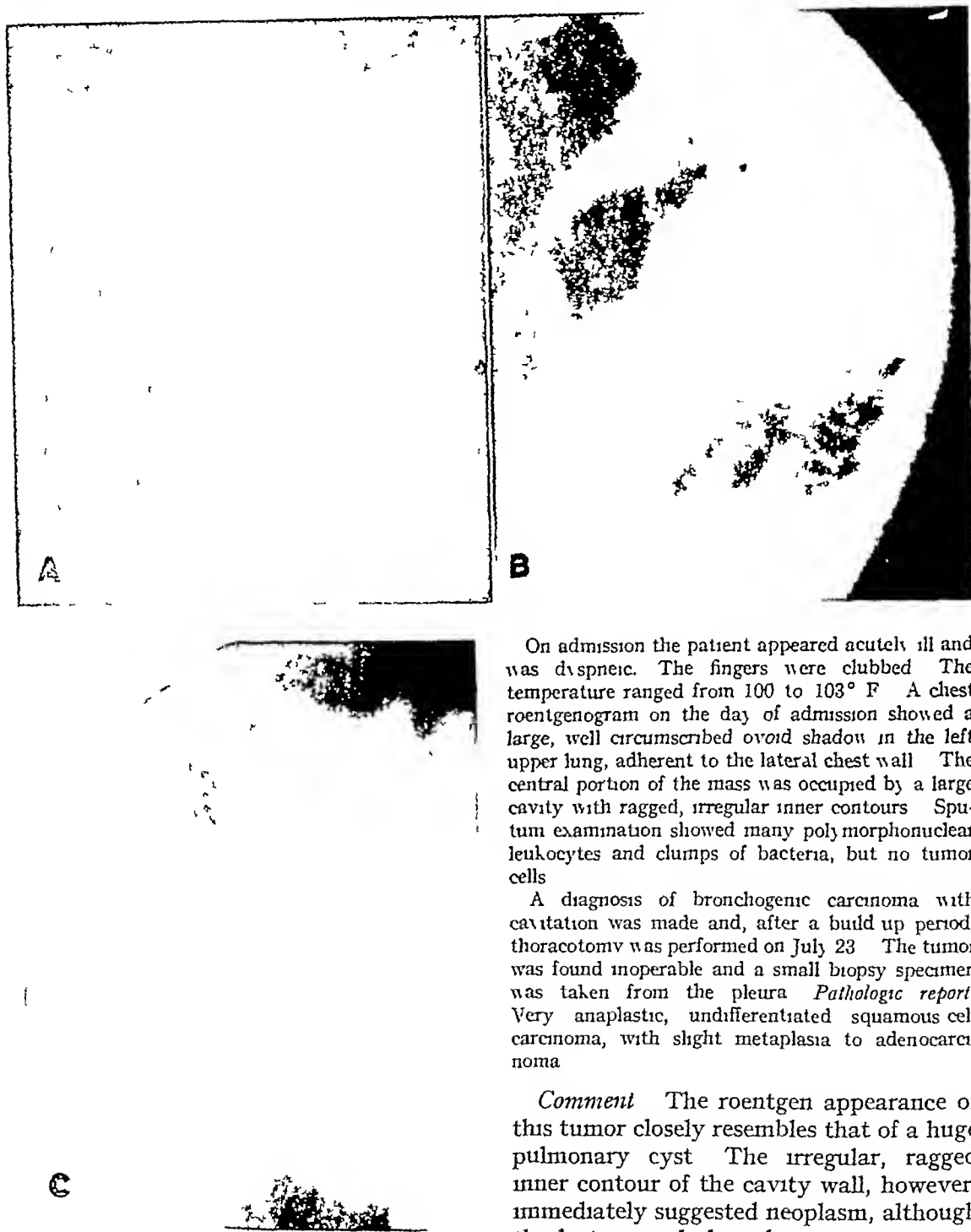


Fig 1 Case I A Well circumscribed ovoid mass in left lung with irregular ragged cavity B Left lateral view showing mass located posteriorly C Planigram demonstrating irregular, bumpy contour of cavity wall

sputum was often blood tinged. He also complained of pain in the chest, which was aggravated by coughing.

On admission the patient appeared acutely ill and was dyspneic. The fingers were clubbed. The temperature ranged from 100 to 103° F. A chest roentgenogram on the day of admission showed a large, well circumscribed ovoid shadow in the left upper lung, adherent to the lateral chest wall. The central portion of the mass was occupied by a large cavity with ragged, irregular inner contours. Sputum examination showed many polymorphonuclear leukocytes and clumps of bacteria, but no tumor cells.

A diagnosis of bronchogenic carcinoma with cavitation was made and, after a build up period, thoracotomy was performed on July 23. The tumor was found inoperable and a small biopsy specimen was taken from the pleura. *Pathologic report*: Very anaplastic, undifferentiated squamous cell carcinoma, with slight metaplasia to adenocarcinoma.

Comment The roentgen appearance of this tumor closely resembles that of a huge pulmonary cyst. The irregular, ragged inner contour of the cavity wall, however, immediately suggested neoplasm, although the history and clinical picture were consistent with infected fluid cyst or lung abscess.

CASE II (Fig 2) A 62-year old white man came to the Birmingham Veterans Administration Hospital Outpatient Service on Oct 28, 1947, because of anginal pain occurring in the xiphoid region following exertion. It was a steady, squeezing type of pain

requiring immediate rest for relief. Roentgen examination of the chest on that day revealed a rounded, discrete shadow in the right base which suggested the possibility of abscess, bronchogenic carcinoma of the peripheral type, or a metastatic neoplasm. The patient was hospitalized for further investigation. On Nov 18, 1947, re examination disclosed the same shadow, showing evidence of central necrosis, with an irregular inner cavitory wall. The lateral film located the lesion in the middle of the right lower lobe just above the diaphragm.



Fig 2 Case II Rounded well circumscribed shadow in right base. Note irregular cavitation in upper part of mass.

The patient gave an additional history of having had a similarly located but smaller lesion pointed out to him on a chest film in 1920. This fact, accompanied by a 3-plus tuberculin skin test, suggested clinically a tuberculoma undergoing excavation. Skin tests for coccidioidomycosis were negative.

Bronchoscopy revealed no evidence of tracheobronchial disease. However, thick non-purulent secretions were noted coming from the right lower lobe bronchus. Cultures of these secretions were negative for acid fast organisms. There was a heavy growth of non-hemolytic *Staphylococcus aureus*.

In spite of the cardiovascular symptoms and electrocardiographic patterns, which varied from day to day from normal to those suggesting anterior myocardial ischemia, the patient was operated upon on Feb 11, 1948, and the right lower lobe was removed. The pathological report was squamous cell broncho-



Fig 3 Case III Patchy infiltrations in upper two-thirds of both lungs, with scattered nodular calcifications in the right apex and subapex. Two large cavities are seen on the left near the hilus. There is emphysema of both bases, with thickened pleura over the diaphragm and in the costophrenic angles.

genic carcinoma, peripheral type, undergoing cavitation.

Comment This case illustrates cavity formation in a small tumor. While no definite diagnosis was made preoperatively, radiographically the irregular contours of the cavity wall strongly suggested a malignant neoplasm.

CASE III (Fig 3) A 74-year-old white man gave a history of pulmonary tuberculosis for forty years, with positive sputum tests at various times at different Veterans Administration hospitals. In the last two months he had lost 27 pounds and noticed increasing weakness. His cough had been growing gradually worse and the sputum was often blood-stained. He entered this hospital on Oct 15, 1946.

A chest film (Oct 17, 1946) showed dense infiltrations involving the upper two thirds of both lungs, with two large cavities on the left. Both bases were emphysematous and the pleura was thickened over the diaphragm and in the costophrenic angles. Sputum was positive for acid-fast bacilli on two occasions. The clinical and roentgen diagnosis was far-advanced bilateral pulmonary tuberculosis with cavitation.

After a month's stay, the patient left the hospital against medical advice, but re entered two weeks later (Dec 3, 1946) because of rapidly increasing weakness. He died on Dec 27, 1946.

On autopsy both lungs were found to be studded with confluent nodules of gray tumor tissue. In the



Fig 4 Case IV A Large mass in right apex, well circumscribed below. Note eccentric location of cavity laterally and inferiorly, also rib destruction B Plaingram demonstrating markedly irregular and ragged appearance of cavity

left lung were two large nodules, one 3 cm and the other 4.5 cm in diameter, both excavated. Microscopic examination of the cavitating tumors showed them to be composed of groups of undifferentiated squamous cells, occupying the alveolar spaces and invading the perivascular and peribronchial lymph spaces. The tumor cells were anaplastic, had hyperchromatic nuclei and showed abnormal mitotic figures. There were small rudimentary horn pearls. Careful search was made for tuberculous lesions, on a large number of microscopic sections, but none could be found.

Pathologic diagnosis 1 Squamous cell carcinoma, left upper lobe (peripheral type), with multiple metastases to both lungs 2 Metastasis to the right kidney and adrenal

Comment Assuming the recent positive sputum tests to have been correct, indicating the presence of active tuberculosis at the time of death, the failure to find tuberculous lesions postmortem can still be explained by the tremendous predominance of neoplastic tissue. From the roentgenologic point of view, we may assume that the active tuberculosis, if present, was located chiefly in the right upper lobe, because of the presence of an old fibro-calcific lesion in that area. The unique feature

of this case is that the cavities in the left upper lobe were neoplastic. The excavation, however, was so complete that no characteristic wall contours could be seen, and no suspicion of cancer was entertained until postmortem examination disclosed the true nature of the lesion.

CASE IV (Fig 4) A 50 year old white male entered the hospital on Jan 14, 1948. He had first noticed pain in the right shoulder blade in July 1947. The pain became gradually worse and eventually involved the entire right upper chest, radiating down the right arm. There had been one attack of hemoptysis in November, yielding 2 or 3 ounces of blood, following which the sputum was blood streaked for a few days. A weight loss of 15 pounds had occurred in the six months since the onset of pain.

On admission the patient showed a Horner's syndrome, moderate clubbing of the fingers, and tenderness over the right shoulder and scapula. He had a low grade fever, up to 99° F. X-ray examination of the chest on the day of admission showed a large, well circumscribed mass in the right apex, with irregular cavitation in the lower antero-lateral aspect. There was destruction of the anterior half of the first rib and the posterior half of the second rib. Bronchoscopy, on Jan 15, was negative. Biopsy of a palpable lymph node from the



Fig 5 Case V A Round, well circumscribed mass in right upper lung field, with eccentrically located cavity
B Planigram, demonstrating irregularity of cavitation

right supraclavicular region was reported as metastatic squamous cell carcinoma. The tumor was regarded as inoperable.

Comment This was an obvious case of "superior sulcus tumor" and presented very little diagnostic difficulty, at least as far as determination of its malignant character was concerned. It is presented in this group because it demonstrates the eccentric location and irregular ragged wall of the cavity.

CASE V (Fig 5) A 38-year old white man entered the hospital on March 10, 1947, complaining of a cough productive of blood streaked sputum. This had been present intermittently during the preceding two years and was accompanied by a weight loss of 40 pounds. The patient had been discharged from the Armed Forces at approximately the time of onset of his presenting complaints, but six months later was refused employment because a chest film showed a "spot on the lung." A roentgenogram of the chest obtained on March 12 showed a large mass in the right upper lung posteriorly. It was fairly well margined along its lower border. Planigrams showed ragged multilocular cavitation eccentrically located in the apical portion of the tumor. Biopsy of a palpable axillary lymph node showed reticulum cell sarcoma. The patient was transferred elsewhere for deep x-ray therapy.

Comment This case has been included in the present group because it again demonstrates the eccentric location of the cavity and the irregular, ragged contours of the cavity wall.

SUMMARY AND CONCLUSIONS

Early differential diagnosis between inflammatory and malignant lesions of the lung is not always possible. Moreover, no pathognomonic signs of pulmonary neoplasm exist at any stage of the disease, either clinically or roentgenographically. Cough, hemoptysis, pain in the chest, and weight loss, in a patient over forty years of age, must be assumed to indicate a pulmonary neoplasm until proved otherwise.

The type of pulmonary neoplasm most often confused with infection is the cavitary form of bronchogenic carcinoma. Roentgenologically, differentiation must be made from infected fluid cyst, lung abscess, and tuberculosis. The eccentric location and irregular, ragged inner contour of the cavity should direct attention to the probability of a malignant growth.

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SUMARIO

Forma Cavitaria de Neoplasia Pulmonar

No siempre es posible hacer el diagnóstico diferencial temprano entre las lesiones inflamatorias y malignas del pulmón. Tampoco existen signos patognomónicos, ni clínicos ni radiográficos, de neoplasia pulmonar en ningún período de la dolencia. Hasta que se demuestre lo contrario, debe presumirse que la presencia de tos, hemoptisis y pérdida de peso en un sujeto de más de cuarenta años indica neoplasia.

El tumor pulmonar que más a menudo se confunde con infección es la forma cavitaria del carcinoma broncogénico. Roentgenológicamente, hay que diferenciar el último, de quiste seroso infectado, absceso pulmonar y tuberculosis. La localización excéntrica y el contorno interno mellado e irregular de la cavidad deben hacer pensar en la probabilidad de tumor maligno.



High-Kilovoltage Radiography¹

E DALE TROUT, D E GRAVES, and D B SLAUSON

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LIKE THE OTHER factors involved in radiography, the kilovoltage factor has been the subject of almost continuous study. The equipment available has always had a profound influence on the voltage range over which routine work could be done. At no time has there been any universally accepted technic for any single part of the body. Personal preference and experience have in general been the dominant factors in determining the kilovoltage used in most laboratories.

In its infancy radiography was limited, by the generators and tubes available, to relatively low voltages. With the advent of the alternating current transformer, mechanical rectifiers, and the Coolidge tube, the kilovoltage was increased. The universal type, fine-focus Coolidge tube was frequently used at 100 kv p for radiography of the lumbar spine and the chest in large patients.

When the radiator-type tube became available, the voltage was limited to 85 kv p, a limitation willingly accepted because of the improved definition made possible by the smaller focal spot. For some years, the voltage factor received little attention, as improved films and screens and increased tube current reduced the exposure time required. During this period, there was a general tendency toward higher contrast through the use of reduced voltage. There were some centers of influence, however, where increased latitude was preferred at the expense of contrast, at least for some regions of the body.

In the last few years, the question of the use of higher kilovoltage has become the subject of considerable discussion. This would seem to be the result of a number of contributing influences. Notable are the

works of Fuchs, Hodges, Morgan, and their associates. The recent works of Lamerton and of de Waard have contributed to a better understanding of scattered radiation, always of prime importance when the effect of voltage on the radiograph is to be considered.

No small part of the interest in increased voltages can be traced to their use in mass radiography. Further impetus has come from renewed interest in cineradiography and fluoroscopic intensification.

The work reported here had its inception in some work done by Files and his co-workers in 1944 and 1945 during their search for an optimum ratio grid. A dry spine and wire mesh suspended in a water phantom were used as test materials. It was soon evident that increased grid ratios (greater than 8:1) were feasible and that they made possible a marked reduction in the amount of scattered radiation reaching the films. Grids of ratios as high as 34:1 were studied. At the increased ratios, the exposure time became so great that, to reduce it to usable limits, higher voltage became necessary. As the voltage was increased, the exposure decreased, as had been anticipated, but at a rate considerably in excess of that expected. The higher ratio grids made possible a high degree of contrast even at much higher voltages than were in general use at the time. As the voltage was increased, one disturbing factor crept into the picture. This was a seeming loss of definition occurring between 110 and 120 kv p and persisting at all voltages above this. At the time it was thought that this might be caused by some change in the grain characteristics of the intensifying screens. During that period, the study of grain char-

¹ Presented at the Thirty fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif. Dec 5-10, 1948

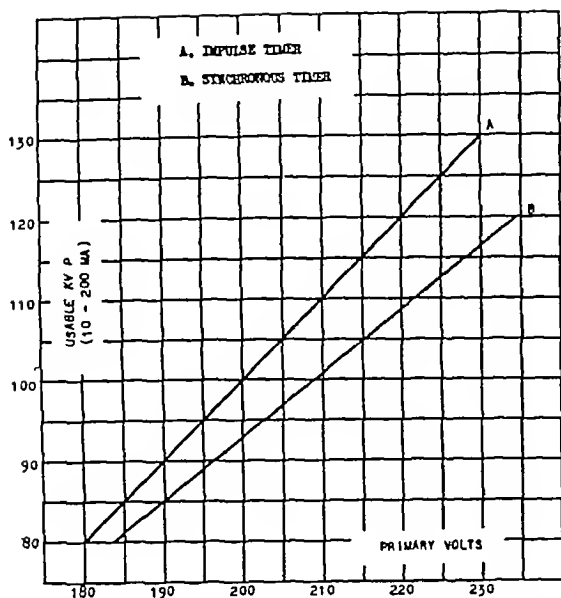


Fig 1 Primary voltage vs usable kilovoltage for a high-voltage system using an impulse timer (A) and a synchronous timer (B)

acteristics in film emulsions for use with million-volt radiation in industry was bringing to light some hitherto unexpected facts, and consideration was given to a possible similar effect at lower voltages with light-sensitive materials. At that point, Files' death brought about a temporary halt in the work.

It had become apparent, however, that higher ratio grids were feasible and that a ratio of 16:1 was about the optimum. At that ratio, the improved contrast seemed to just about balance the increased exposure at a practical level.

When work was resumed in 1946, attention was at once focused on the seeming loss of resolution that occurred at voltages above 110 kilovolts. By use of the Morgan method of measuring resolution, it was determined that the use of voltages as high as 135 kv p did not result in any change in this respect with any of the screen and film combinations then available.

One possibility after another was explored until it was determined that the apparent loss of definition was due to scattered radiation reaching the back screen from the cassette back and the Bucky tray. A thin sheet of lead on the

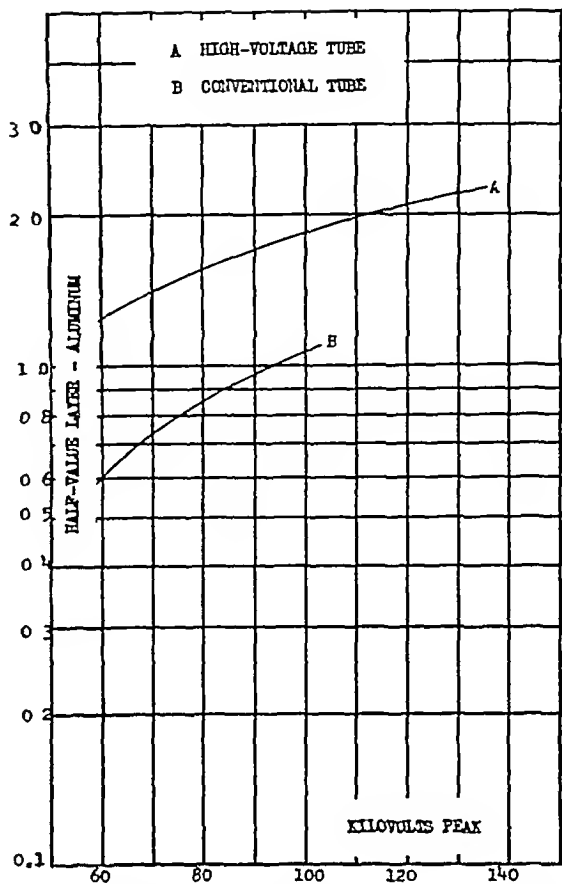


Fig 2 Half-value layer vs kilovoltage for a rotating anode tube of conventional design and a similar tube designed for operation at 130 kilovolts

inside surface of the cassette back was the readily apparent solution. With that barrier passed, there seemed to be no technical reason why higher voltages could not be used to produce radiographs of satisfactory contrast with the higher ratio grids.

Before proceeding further, it was deemed advisable to investigate the changes that might be necessary in equipment to make possible the use of the higher voltages. Fortunately, diagnostic transformers were already available for operation up to 135 kv p at reduced current for superficial therapy. The behavior of these transformers and their controls was studied using high-voltage, short-time exposures at tube currents up to 200 ma. It was found that with minor modifications of bushings and high-tension switches, the operation of such transformers was satisfactory at voltages up to 130 kv p, and tube cur-

rents up to 200 ma , providing consideration was given to the method of switching used to initiate and terminate the exposure. The so-called "synchronous" timer consists of a timing mechanism driven by a synchronous motor. The motor operates at constant speed, providing accurate time

high-voltage transformer and tube system.

The impulse type of timer is not only driven at constant speed but, in addition, is so designed that it initiates and terminates the exposure at the instant the voltage passes through zero. As a result, no transients are set up, and such a timer

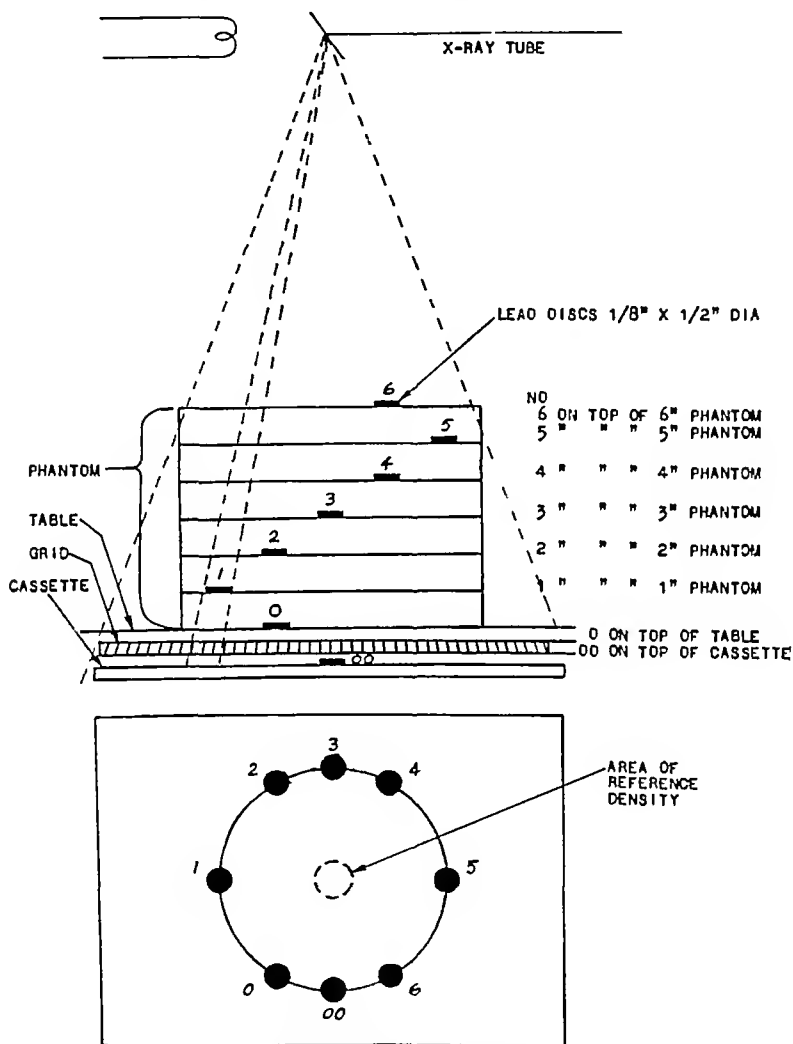


Fig 3 Diagram of a method used to study the relative efficiency of grids and motivating mechanisms

intervals, but the exposure may be started or ended at any point in the voltage wave. If the switching operation takes place at any point other than the zero point in the voltage wave, switching transients are set up in the high-voltage system. At voltages about 120 kv p these transients may reach a level that will bring about a failure of the insulation somewhere in the

makes possible satisfactory operation at any voltage up to the rating of the high-voltage system and the tube with which it is used. The use of the impulse timer is advisable at any voltage where its timing range is adequate. With present tubes and transformers, its use is mandatory for voltages about 120 kv p.

The data from which this conclusion is

drawn are plotted in Figure 1 Here, the primary voltage is plotted against the usable voltage that will not inject harmful transients into the high-voltage system when the two types of switching are used

Some modification of the x-ray tube and container was found to be necessary The changes had to do chiefly with improved

ventional rotating-anode tube and a similar tube designed for operation at voltages up to 130 kv p Radiographic studies indicate that this increased filtration does not produce a perceptible change in radiographic quality at voltages above 40 kv p Below 40 kv p there is a decrease in background density

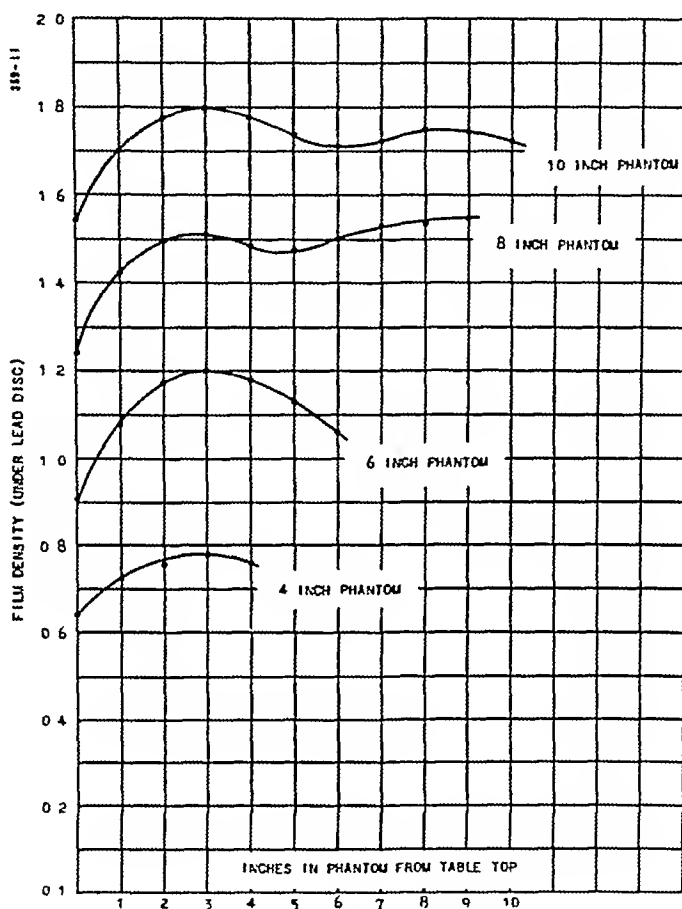


Fig 4 Results plotted from data taken at 100 kilovolts peak with an 8 1 grid in a single-stroke mechanism and phantom thicknesses of 4, 6, 8 and 10 inches

dielectric conditions One of these changes was an increase in the thickness of the tube window to decrease the possibility of puncture at the higher voltages The increase in window thickness, of course, resulted in an increase in the inherent filtration of the tube system The extent to which this change influences the quality of emitted radiation can be seen in Figure 2 Here, the half-value layer in aluminum has been plotted against voltage for a con-

At this point the project seemed to be completed Tubes and energizing equipment for operation at voltages up to 130 kv p did not require any radical changes that might make their cost prohibitive The 16 1 grid made possible excellent contrast Voltages above 130 kv p did not seem warranted, for at 130 kv p exposures were so short as to begin to tax present timing methods

The project was not closed out at this

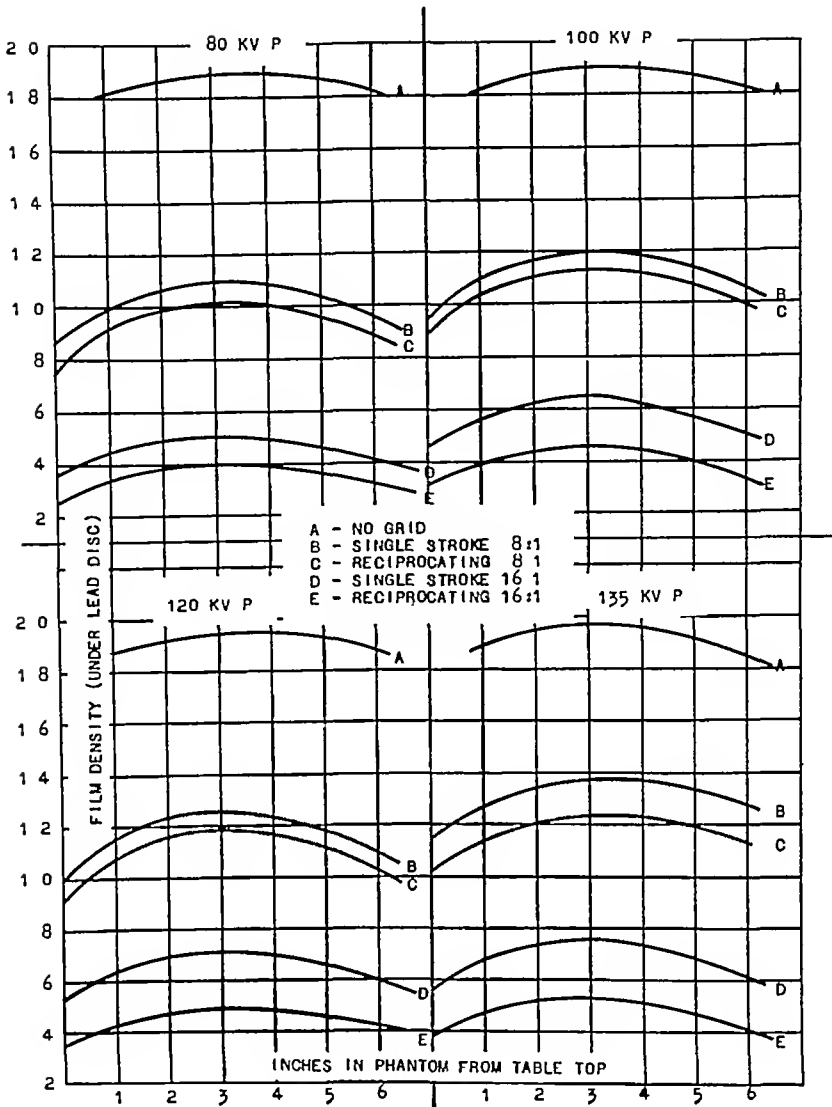


Fig 5 Data showing film density produced by scattered radiation using 8:1 and 16:1 grids in single-stroke and reciprocating mechanisms

point, however, because the Liebel-Flarshiem reciprocating Bucky became available. Up to this time, the work had been done using the single-stroke Bucky mechanism. The reciprocating mechanism was so attractive from many functional points of view that it seemed worth while to review the whole problem.

It had gradually become apparent that some better method was needed to evaluate the results produced by the different grids and their motivating mechanisms. It was becoming too difficult to evaluate the radiographs visually, and the number of expo-

sure involved prohibited the use of patients as test material.

In a study previously carried out on another problem, it had been necessary to find a test material that could be used for radiographic tests. Water and other liquids imposed handling and container difficulties. Masonite gave a mottled pattern that made it difficult to measure film densities. Dr. Frank Schulze of the Chemical Division of the E. I. du Pont de Nemours Company suggested a material that proved to be so satisfactory that it has been used for all subsequent work. This material

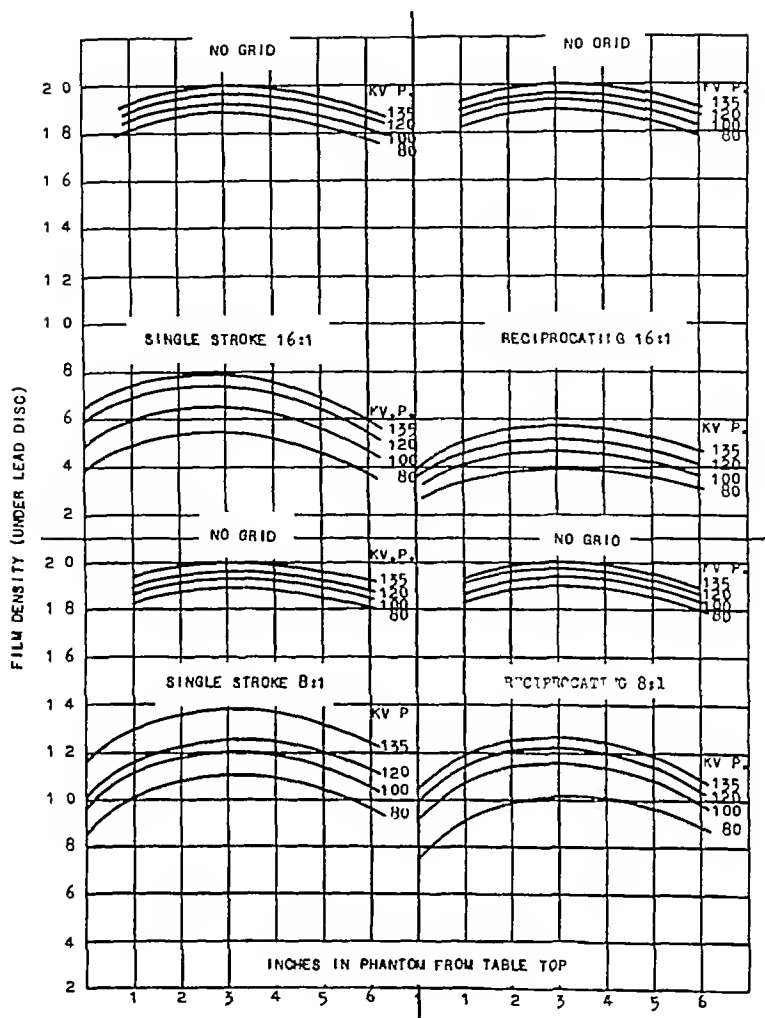


Fig 6 Film density produced by scattered radiation for each of four grid-mechanism combinations at 80 100 120, and 135 kilovolts

is essentially the material used in printers' inking rollers. Its base is brown glue. Properly prepared, it has a density very close to unity. Thickness for thickness, it compares very favorably with average tissue. It can be prepared in sheets that can be stacked to make up a test phantom of any reasonable thickness. One must be prepared to tolerate a not-too-pleasant odor during the curing period.

In reviewing the literature on methods for evaluating grids, one cannot fail to be impressed by the work of Wilsey in the early days of the Potter-Bucky diaphragm. After a review of all the possibilities, it was decided that if modern technology was applied, Wilsey's ideas could be expanded

and refined to give a method that could be used to procure a graphic evaluation of the efficiency of any grid system.

Figure 3 shows the method finally used. A number of lead discs 1/2 inch in diameter were cut from 1/8-inch sheet lead. One of these, designated as 00, was placed directly on top of the cassette. One, designated as 0, was placed on the table top. Others, designated as 1, 2, 3, 4, etc., were placed in the phantom material at corresponding 1-inch levels, as measured from the table top. Thus, if a 6-inch phantom was being used, disc number 2 was in the phantom 2 inches from the table top, and disc number 6 was on top of the phantom and 6 inches from the table

top By arranging the discs in a spiral in the phantom, their images appeared on the film in a circle Exposures were made to bring the film density at the center of this circle to some selected density Having done this, the film densities under the lead discs were a measure of the scattered

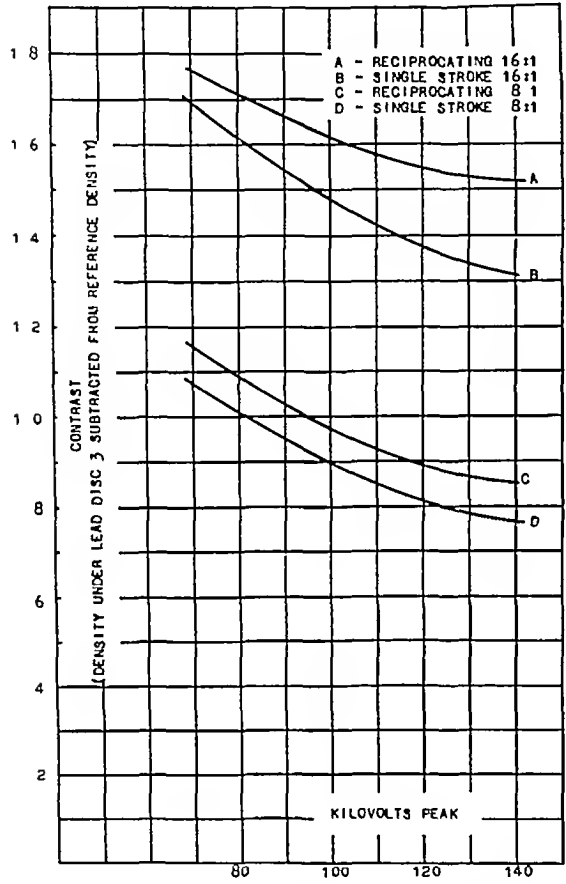


Fig 7 Contrast number vs kilovolts peak for 8:1 and 16:1 grids in single stroke and reciprocating mechanisms

radiation reaching the film from the various levels in the phantom The density under disc 00 was due to chemical fog produced in processing, that under disc 0 was due to radiation scattered into the volume between the table top and the film, that under disc 1 was due to radiation scattered into the volume defined by the disc and one inch of phantom, etc When the density under disc 00 (fog density) was subtracted from the density under the lead discs, the resulting values became measures of the

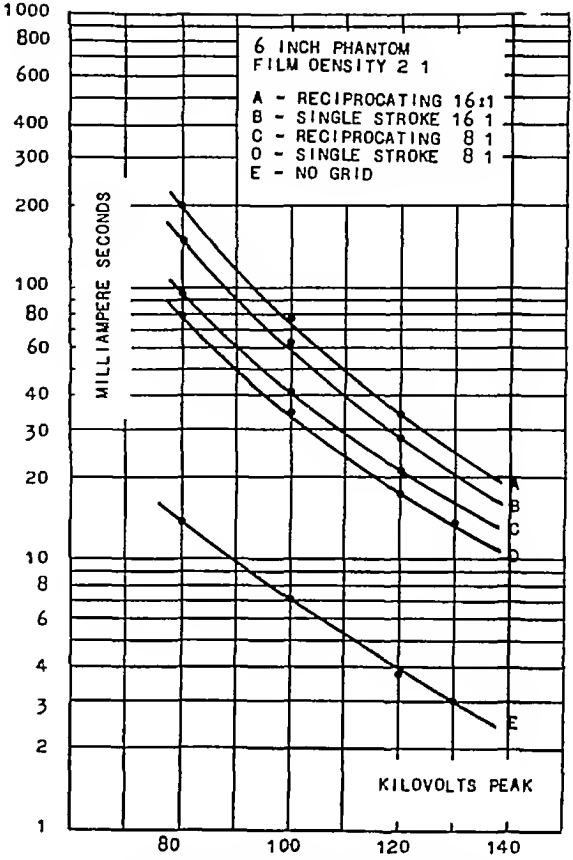


Fig 8 Comparative exposures in milliamperes seconds vs kilovolts peak for a 6 inch phantom

efficiency with which any grid and motivating mechanism prevented scattered radiation from reaching the film Furthermore, it provided a measure of the contrast that could be expected at various voltage levels

Carefully controlled exposures were necessary to bring the reference density in the center of the circle formed by the discs to an exact reference density Control of the film processing was one of the most difficult problems encountered In general, the procedure was to explore a given set of conditions until all factors had been decided upon A complete series of films covering the variable under study was then exposed and processed at one time

In Figure 4 are plotted the data from a study made at 100 kv p at 40 inches using an 8:1 grid in a single stroke mechanism with phantoms 4, 6, 8, and 10 inches thick The reference density was 2 As might be expected, the density due to scattered

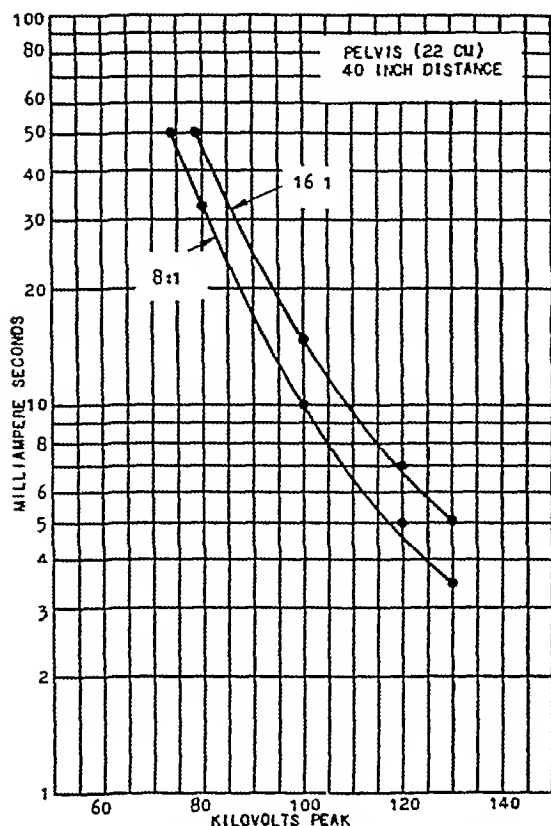


Fig 9 Exposure vs kilovolts peak for radiograph of a pelvis using S 1 and 16 1 grids in a reciprocating mechanism.

radiation increased as the phantom thickness increased. An increase from 4 to 8 inches just about doubled the density under disc number 3. The unexpected thing was that the density always was at a maximum under this disc. This condition prevailed over the more than one hundred radiographs made under all conditions over a period of some months. There may be a simple explanation for it but, if so, the authors made no hit upon it.

Four sets of conditions were studied at voltages of 80, 100, 120, and 135 kv p. These conditions involved an 8 1 grid in a single stroke mechanism, the same grid in a reciprocating mechanism, a 16 1 grid in the single stroke mechanism, and a 16 1 grid in a reciprocating mechanism. Medium-speed screens with the usual radiographic films were used. No special chemicals were employed in processing the exposed films.

A set of data taken with a 6-inch phan-

TABLE I COMPARATIVE EXPOSURE DATA FOR PELVIS (22 CM.)

Grid	Kv p	Ma	Factor
S 1	80	32	1 00
S 1	100	10	0 45
S 1	120	4 6	0 14
S 1	130	3 5	0 11
16 1	80	46	1 00
16 1	100	15	0 33
16 1	120	6 9	0 15
16 1	130	5 0	0 11

TABLE II COMPARATIVE EXPOSURE DATA FOR LATERAL LUMBAR SPINE (30 CM.)

Grid	Kv p	Ma	Factor
S 1	80	200	1 00
S 1	100	75	0 37
S 1	120	39	0 20
S 1	130	30	0 15
16 1	80	400	1 00
16 1	100	125	0 31
16 1	120	55	0 14
16 1	130	40	0 10

tom with no grid and with the various grid combinations is shown in Figure 5. It is readily seen that the 8 1 grid in the reciprocating mechanism removes more of the scattered radiation than the same grid in a single-stroke mechanism. The same is true with the 16 1 grid, and the improvement with either grid in the reciprocating mechanism becomes more pronounced as the voltage is increased. It is also seen that the 16 1 grid in either mechanism when used at 135 kv p produces a higher degree of contrast than is obtained with the 8 1 grid at 80 kv p.

In Figure 6 the same data are plotted to bring all the values for a single grid and mechanism together. For purposes of record, a contrast number was obtained by subtracting the density under disc 3 from the reference density. The comparative exposure characteristics of the two grids and two mechanisms are shown in Figure 8 for a 6-inch phantom.

Having determined that the reciprocating mechanism was preferable to the single-stroke mechanism and that the 16 1 grid could be used to produce satisfactory contrast at the higher voltages, the next step was to transfer the experimental results into the making of radiographs on living subjects. In making patient radio-

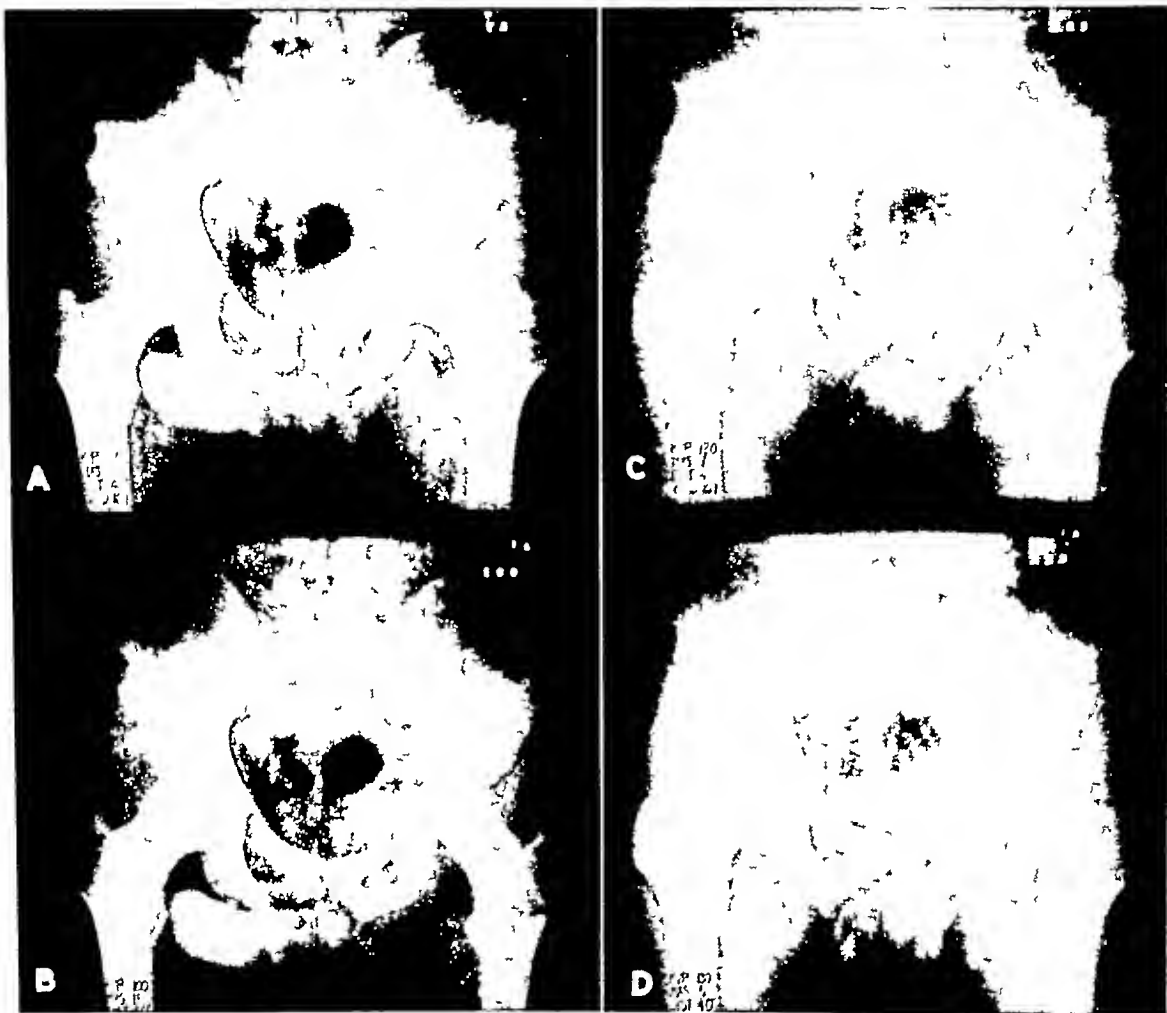


Fig 10 Radiographs of pelvis using 16 1 reciprocating grid at 78, 100 120, and 130 kilovolts peak A 78 kv p 50 ma 40 in distance 16 1 grid B 100 kv p 15 ma, 40 in distance 16 1 grid C 120 kv p, 7 ma, 40 in distance, 16 1 grid D 130 kv p, 5 ma, 40 in distance 16 1 grid

graphs, densities were matched visually, as would be the case in actual practice

As might be expected, a pelvis was the first part studied. The results using the 8 1 and 16 1 grids in the reciprocating mechanism are plotted in Figure 9 and tabulated in Table I. The relative exposure for each grid at 80, 100, 120, and 130 kv p is shown in the last column. It will be seen that the exposure with the 16 1 grid is about one and one-half times that for the 8 1 grid at any given voltage. For a given exposure at the 75 kv p level, the 16 1 grid requires an increase of about 4 kv p over the 8 1 grid. This increases to about 12 kv p at the 120 kv p level.

It is difficult to show other than gross differences in radiographs when they are reduced to print, but it is hoped that Figure 10 will serve to indicate the type of radiographs used in arriving at the data shown.

Similar results obtained from radiographs of a lateral lumbar spine are shown in Figure 11 and Table II. Differences between the comparative exposure factors for the pelvis and the spine are probably due to the inability of the eye to match densities exactly and the difference in contrast levels that further complicate the problem for the eye. In all cases, the densities were probably more nearly uniform than those encountered in actual practice.

The results to be expected with higher

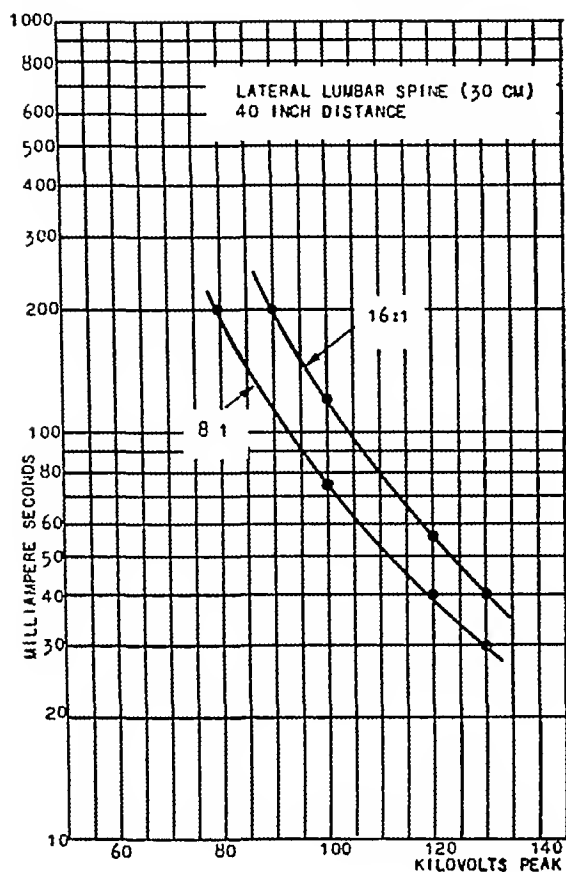


Fig 11 Exposure vs kilovolts peak for lateral lumbar spine, using 8:1 and 16:1 grids in reciprocating mechanism

voltage in the postero-anterior and lateral radiography of the chest were studied without a grid and with a stationary focused grid. The grid used was focused for 42 inches and had a ratio of 5:1. Radiographs were made using a 72-inch distance. The results are shown in Figs 12 and 13 and Tables III and IV. Some idea of the type of radiographs possible may be had from two such series shown in Figures 14 and 15.

The opportunity to see what might be done with radiography of an extremity could not be ignored. Two series of radiographs of a leg were made without a grid. One series was made using intensifying screens, the other using no-screen film. The results are plotted in Figure 16.

To date hundreds of radiographs have been made. The impression persists that films of high quality are possible at the

TABLE III COMPARATIVE EXPOSURE DATA FOR POSTERO ANTERIOR CHEST RADIOGRAPH (22 CM)

Grid	Kv p	Ma	Factor
None	60	10	1.00
None	80	3	0.30
None	100	1.2	0.12
None	120	0.6	0.06
None	130	0.5	0.05
5:1	80	6	1.0
Stationary grid	100	2.5	0.42
	120	1.4	0.23
	130	1.0	0.06

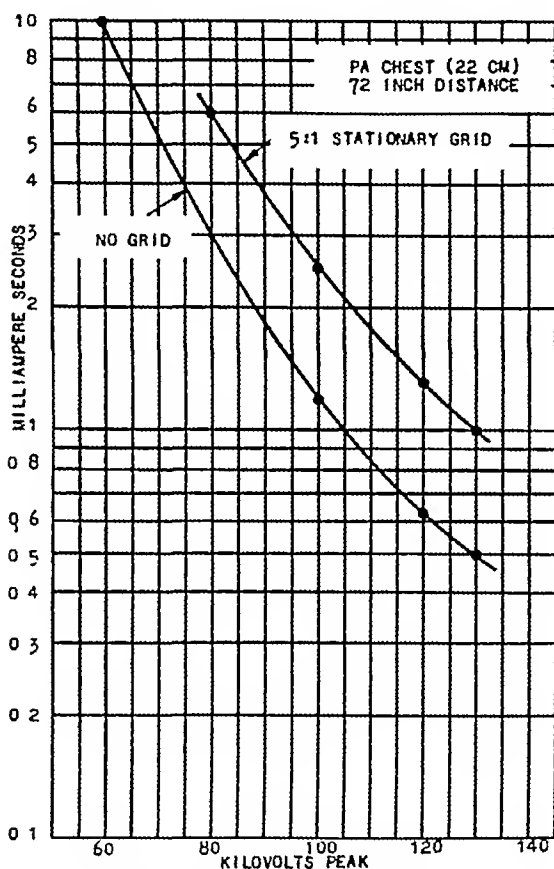


Fig 12 Exposure vs kilovolts peak for postero-anterior chest radiograph

higher voltages. The contrast can be maintained by using the 16:1 grid. The latitude is especially striking in these radiographs. For the first time, it becomes possible to put on the medical films something approaching the qualities obtained in industrial radiography, where heavy lead filter screens are used at voltages up to one and two megavolts. Over a wide range of voltage, the changes are such as to leave little doubt of the value of higher voltages.

TABLE IV COMPARATIVE EXPOSURE DATA FOR LATERAL CHEST RADIOGRAPH (32 CM)

Grid	Kv p	Ma	Factor
None	80	20	1 00
None	100	8	0 40
None	120	4	0 20
None	130	3	0 15
5 1	80	40	1 00
Stationary grid	100	16	0 40
	120	8	0 20
	130	6	0 15

for some types of work. High voltage and the increased latitude that goes with it may not always be desirable. Fortunately, the changes in equipment to make the use of higher voltages possible does not preclude the use of presently accepted technics to obtain radiographs with the characteristics now looked on as desirable. The use of high-ratio grids and higher voltages should be looked upon as a means of obtaining an improved result in certain types of work, this result being obtained with short exposures without loss of contrast.

One of the interesting possibilities which we have not had time to work on is the use of higher voltages with the fine-grain type of intensifying screen usually referred to as "detail" or "high"-definition screen. The use of higher voltages may make the routine use of such screens possible, since the exposure time need not be prohibitive.

Not the least interesting thing on which to speculate is the effect of increased voltage on the exposure which is received by

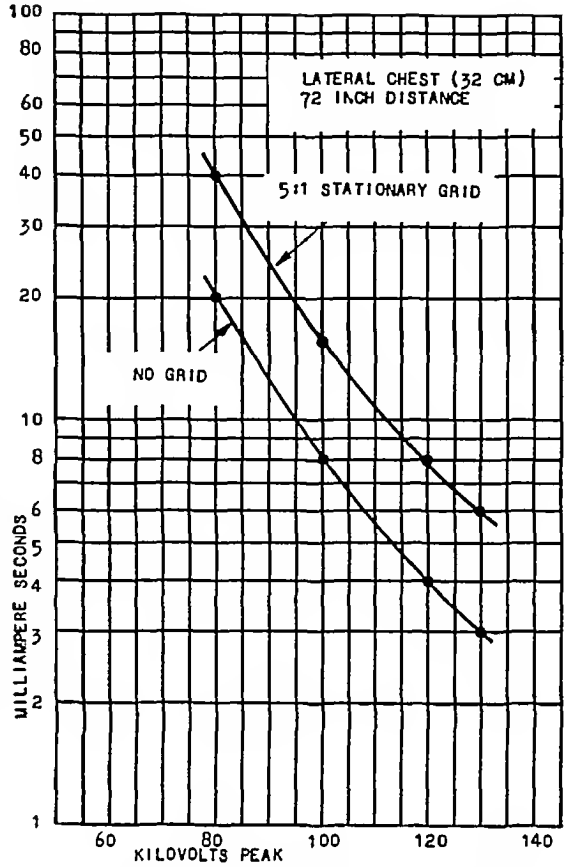


Fig 13 Exposure vs kilovolts peak for lateral chest radiograph

the patient. As pointed out earlier in this discussion, the increased inherent filtration in the tube necessary for high-voltage operation brings about an increase in the half-value layer of the emitted radiation. This is, of course, accompanied by a de-

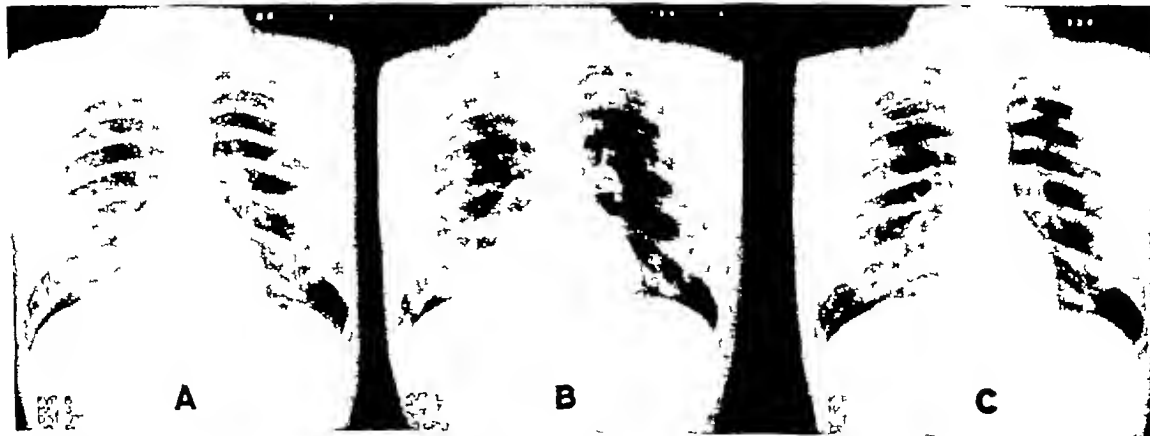


Fig 14 Postero anterior radiographs of chest. A. 80 kv p, 3 ma, 72 in distance, no grid. B. 130 kv p, 1/2 ma, distance 72 in, no grid. C. 130 kv p, 1 ma, 72 in, 5 1 grid.

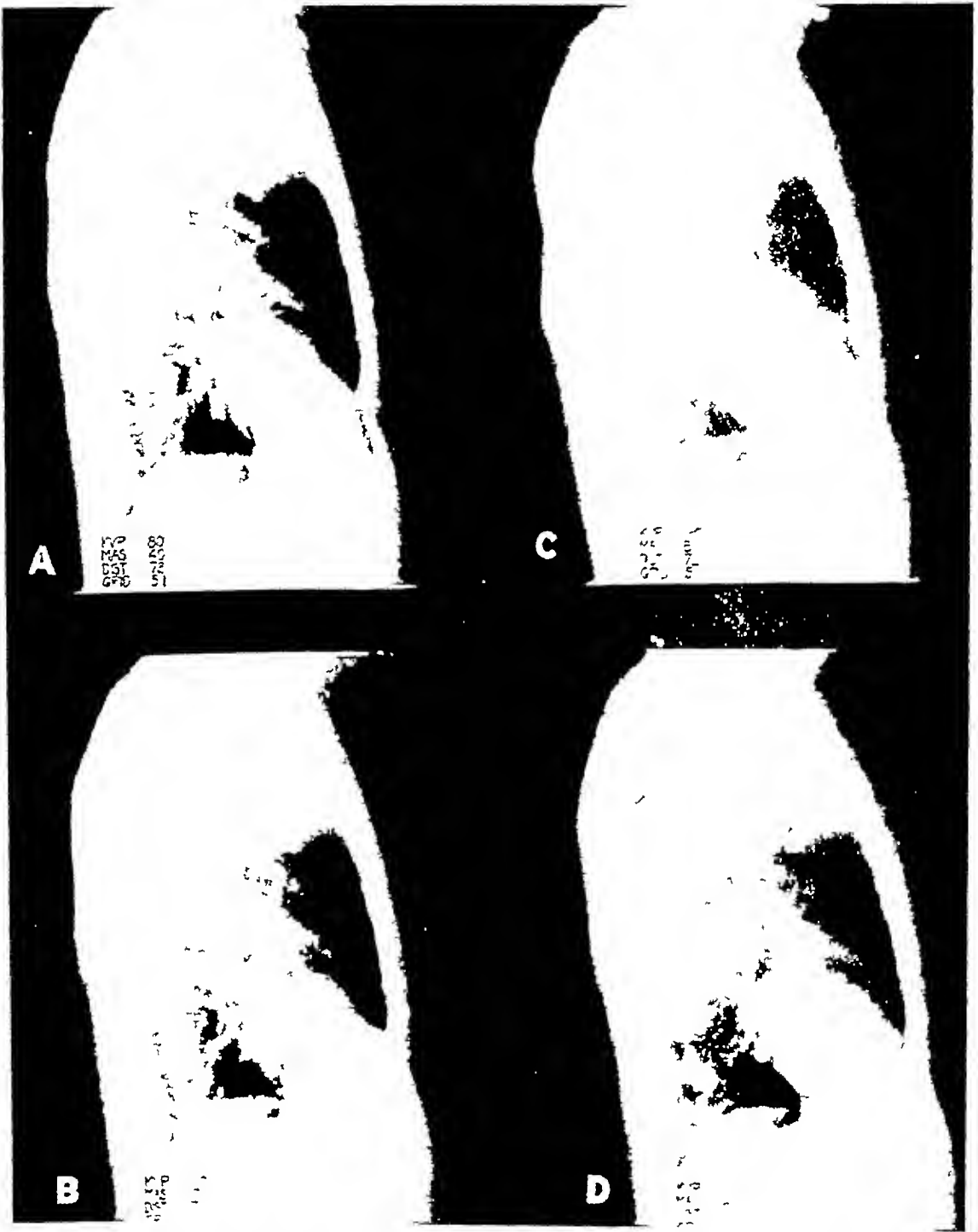


Fig 15 Lateral radiographs of chest A 80 kv p 40 ma , 72 in distance 5 1 grid B 100 kv p 17 ma 72 in distance 5 1 grid C 120 kv p 8 ma , 72 in distance, 5 1 grid D 130 kv p , 6 ma , 72 in distance 5 1 grid

crease in the intensity in roentgens per milliampere-second The order of this change can be seen in Figure 17, in which is plotted the intensity obtained from the tubes used for the major portion of the work

reported here It will be noted that the intensity from the high-voltage tube is about one-half that from the conventional tube An analysis of the skin exposure in the case of an 8-inch (20-cm) pelvis is of

interest The conventional tube used at 80 kv p and a 40-inch focal film distance would deliver 0.023 r per milliamper-second to the skin Using the 8:1 grid, an exposure of about 30 milliamper-seconds would be required, bringing the dose to the skin to about 0.7 r

If the high-voltage tube and the 16:1 grid were used at 130 kv p, the intensity

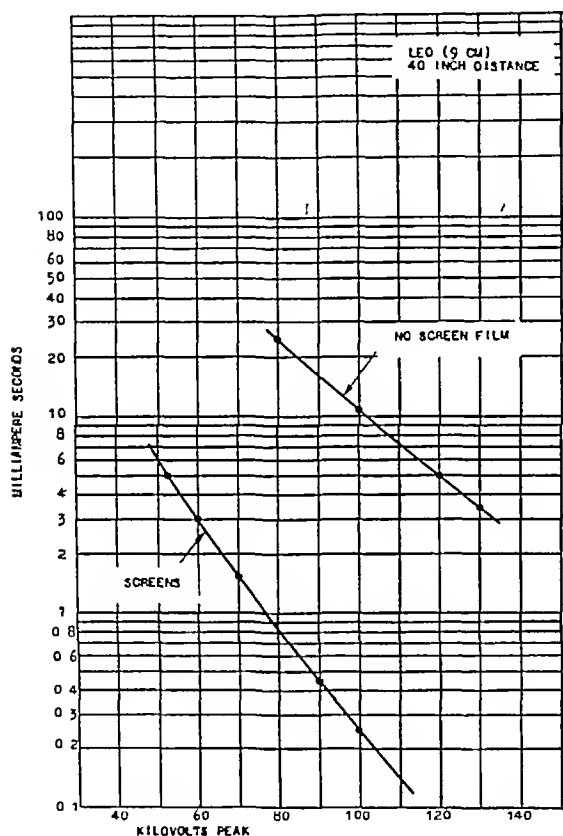


Fig 16 Exposure vs kilovolts peak for leg

would be approximately 0.019 r per milliamper-second The exposure would be about 5 milliamper-seconds and the skin dose only 0.095 r Something approaching the same result could, of course, be had by adding aluminum filter to the conventional tube

The skin dose may not be the whole story, however, if effects at a depth are to be considered, the penetrating qualities of the radiation must be taken into account In Table V will be found data taken using the two types of tubes and the phantom employed throughout these stud-

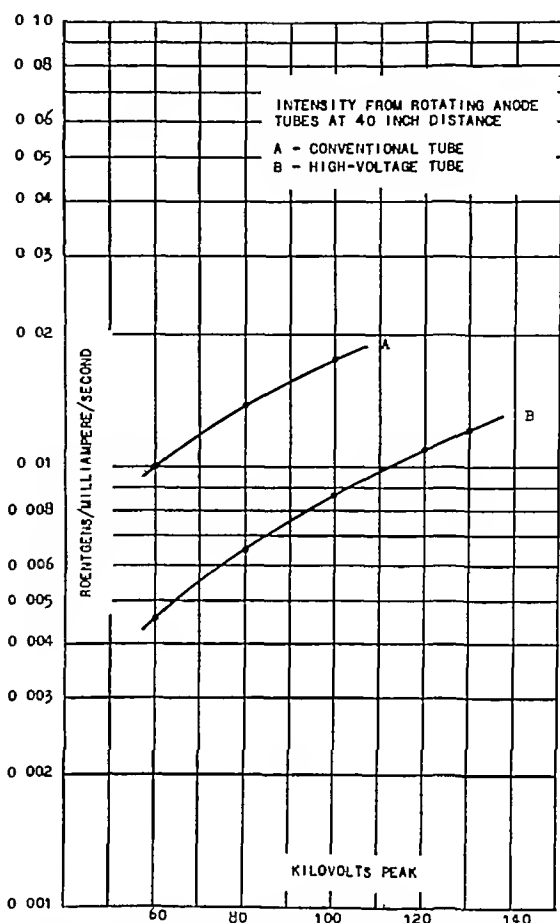


Fig 17 Intensity vs kilovolts peak for conventional and high-voltage rotating-anode tubes

ies It will be seen that through four inches of the material, the transmission will be 2.5 per cent at 80 kv p with the conventional tube and 5.8 per cent at 130 kv p with the high-voltage tube Under these conditions in the radiography of the pelvis, previously mentioned, the transmitted dose through four inches would be 0.0175 r for the 80-kv p technic and only 0.0055 r for the 130-kv technic From this, it would seem that from the standpoint of both the skin dose and the dose to parts below the surface the evidence is in favor of the higher voltage even when the 16:1 grid is used

In conclusion it can be said that

(1) The use of voltages up to 130 kv p is possible without major redesign of equipment

(2) The use of higher ratio grids in a

TABLE V TRANSMITTED RADIATION THROUGH PHANTOM

Phantom (Inches)	Per Cent Transmission							
	Conventional Tube			High voltage Tube				
	60 kv p	80 kv p	100 kv p	60 kv p	80 kv p	100 kv p	120 kv p	130 kv p
0	100	100	100	100	100	100	100	100
1 (2 5 cm)	17	24	25	25	28	34	36	37
2 (5 1 cm)	6	10	12	9 4	12	16	17	18
3 (7 7 cm)	2 6	4 8	6	4 0	6 0	8 0	9 4	10
4 (10 0 cm)	1 2	2 5	3 4	1 8	3 0	4 2	5 4	5 8
5 (12 7 cm)	0 56	1 3	2 0	0 84	1 6	2 5	3 2	3 4
6 (15 3 cm)	0 27	0 7	1 2	0 40	0 86	1 5	1 9	2 1
7 (17 9 cm)	0 13	0 4	0 7	0 19	0 48	0 90	1 15	1 25
8 (20 4 cm)		0 2	0 44		0 26	0 57	0 70	0 78

reciprocating mechanism makes it possible to use the higher voltages without a loss of contrast

(3) The use of the higher voltages increases the latitude to a marked degree

(4) The use of the higher voltages reduces the exposure to such a level that large patients can be radiographed with shorter exposures than was previously possible

(5) The patient dose is reduced by the use of higher voltages

NOTE The authors are indebted to A L Pace, who did the work on grid evaluations

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Milwaukee 14 Wis

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DISCUSSION

Russell Morgan, M D (Baltimore, Md) I find it difficult to assimilate all of these data in a few minutes However, I think that the curves

that were presented showing the amount of radiation to which the patient is subjected as the voltage goes up are rather significant These curves are similar to some that we have obtained You will notice that the dosage diminishes progressively as the voltage increases from 60 kv on up into and beyond the 130 kv range

From conversations that I have had with many manufacturers of x-ray equipment, it looks as though the costs are going to be materially increased by going to the voltages above the 100-kv level, and from the work that we have done, we are a little doubtful as to whether the benefits to be achieved are sufficient to offset these economic factors It begins to look as though the cost of an x-ray generator for high-voltage radiography will be about twice that of a similar generator for 100-kv work, and for my radiographic money I would prefer to have two radiographic rooms equipped with two radiographic generators of 100 kv than to have one room with a generator that could go up to 140 or 150 kv That, of course, is a matter of personal preference, and I would be interested to hear some other comments on this subject

Paul C Hodges, M D (Chicago, Ill) If the films made at these higher voltages are significantly better than the best that can be produced conventionally, then we will have to discard our old equipment The reduction in tissue dosage is laudable, of course, and the shortening of time worth while in the raving of moving parts such as stomach and bowel, but the real question is Will we be able to make clinically better lateral pelvic roentgenograms of heavy subjects?

Unfortunately I was not able to see Mr Trout's exhibit but I shall be on the lookout for his publication

Ross Golden, M D (New York) Three or four years ago, I had the opportunity of seeing some films of some big shells, I believe they were 16-inch shells, taken with one-million volt x rays I was much impressed by the fact that the metal casing could be clearly seen, inside of which was the lesser density of the TNT, and inside the TNT

were air bubbles. In spite of the tremendous voltage, the air bubbles were not obliterated. In clinical radiology, the thing that has impressed me the most is the extraordinary latitude on these higher-voltage films. I like short wave lengths for certain purposes—for example, certain joints—because the rays show bone structure and still do not black out the soft-tissue shadows. I believe that the future will show a usefulness for these higher-voltage machines, of which we have but little concept at the moment. I hope that Mr. Trout and his colleagues will continue their experiments.

Mr. Trout (*closing*). I want to thank the discussants, because that's exactly why we trotted the horse out here this afternoon. You never know whether a horse can run until you put him in a race.

I'm not nearly so pessimistic as Dr. Morgan as to the cost of equipment. I think that for milliamperages up to 200 we have adequate high-tension transformers. Any marked changes that I can see must come in the controls, the change in the tube should be at a minimum. From talking with some of the boys in the tube development section, I gather that the change in the rotating anode to fit the higher voltages would create an additional cost of about \$60.00 to the radiologist. I would guess, if guessing—and I want you to re-

member that it is strictly a guess, and I don't want to be called to account for it—that the increased cost of the generator system will be considerably less than double the present cost.

I'm sorry that Dr. Hodges didn't get a chance to see our films, as we value his opinion very highly. The chief difference that you begin to notice as you go up in kilovoltage is the increase in latitude.

Those of us in industrial radiography during the war received a liberal education in voltages up to two million. We're now building, for industrial radiography, equipment up to ten million volts, so the voltage doesn't scare us too much. The marked increase in latitude is always evident, and we do have available these short exposures for the heavy parts that have caused us considerable difficulty for a number of years. I'm going to be surprised if there is any change in transformer size, because, as the voltage goes up, the current may come down, so that the things will pretty well balance out. I expect that the big field of development, if this thing has possibilities, will be in the same direction that we went when we took a million and two million volt equipment into industry. The film and screen grain size was reduced, so that we got some gain in that direction.

SUMARIO

Radiografía de Alto Kilovoltaje

Las ventajas que pueden obtenerse con el empleo de voltajes más altos en roentgenografía han suministrado tema para discusión por algunos años. Este trabajo describe una serie de experimentos que han abarcado todas las fases del problema. Obsérvese que

(1) El empleo de voltajes hasta de 130 kv p resulta posible sin mayor cambio de la instalación.

(2) El empleo de rejillas de razones más altas en un mecanismo reciprocador per-

mite utilizar los voltajes más altos sin pérdida de contraste.

(3) El empleo de los voltajes más altos acrecienta notablemente la latitud.

(4) El empleo de los voltajes más altos rebaja a tal punto la exposición que los enfermos grandes pueden ser radiografiados con exposiciones más breves que las que eran posibles antes.

(5) El empleo de altos voltajes reduce la dosis por enfermo.

Cinefluorography

A Progress Report on Technical Problems, Dosage Factors, and Clinical Impressions¹

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THE POSSIBILITY of cinefluorography being a procedure of considerable diagnostic importance has appealed to radiologists and others for more than three decades. Its promise, of course, is the improved visualization of the motion of organs and structures now inadequately seen during fluoroscopy. The origin of the technic, and its development to 1930, have been recounted by Jarre in *The Science of Radiology*. His bibliography includes all important early contributions. Since then, workers in both hemispheres, including South America and the Far East, have taken advantage of continued improvements in lenses, fluorescent screens, films, and x-ray generating apparatus, to bring both direct cineradiography and indirect cinefluorography to a level of practical usefulness.

Our interest is in the indirect procedure. The term cinefluorography has been used previously for the indirect method, and we believe it to be an accurate one to describe the making of motion pictures of x-ray images on the fluoroscopic screen.

We began our evaluation of cinefluorography about two years ago. The experimental 16-mm cinefluorographic apparatus that we first employed and the 35-mm equipment that we subsequently adopted have been described by Watson and Weinberg. In the development of these devices and their use, we have had material assistance from representatives of manufacturers of x-ray generating apparatus, lenses, fluoroscopic screens, films, and processing chemicals, and from members of the University of Rochester Department of Optics.

Cinefluorography has been employed for the clinical study of a number of selected cases in our department. As the clinical interest developed, a room was set aside for this sole purpose. The cases investigated have included problems involving swallowing, motility of the alimentary canal, joint motion, and the action of the heart and of the lung structures. The volume of cases studied has not yet been sufficient to permit a statistically adequate evaluation of the diagnostic usefulness of the technic. These studies, however, are proceeding, and the results will be published later. We desire in this paper to describe some refinements of apparatus, the technical procedures we employ, the rationale of the exposure—hence dosage—factors used, and to present some of our tentative impressions thus far of the clinical values of cinefluorography.

TECHNICAL CONSIDERATIONS

The initial description of our 35-mm cinefluorographic equipment was written by Watson and Weinberg in June 1948. Since that time the speed range of the camera has been increased from an upper limit of 32 frames to 60 frames per second. This has the advantage of permitting moderately slow-motion studies of rapid action such as that seen in swallowing. The increase in speed has necessitated the use of a high-speed camera shuttle in place of the standard shuttle. Also, the revolving lead shutter, used at slower speeds to interrupt the x-ray beam during the pull-down phase of the camera cycle, has been temporarily discarded, and the same result achieved more neatly by changing over

¹ From the Department of Radiology, University of Rochester School of Medicine and Dentistry, Rochester, N Y. Presented at the Thirty fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec 5-10 1948.

from full-wave to half-wave rectification. This clever expedient was suggested to us by an article on the work of Rehman of the University of Southern California.

By converting to half-wave rectification, half of the impulses are suppressed and the energy output of the remainder is doubled by increasing the filament current. Proper synchronization of the x-ray generator with the camera shutter permits activation of the tube, and thus of the fluoroscopic screen, only during the open phase of the camera shutter. In most cameras, this is about one half of the camera cycle.

Synchronization of the camera shutter rotation with the power impulses energizing the tube is quite easily accomplished by the use of a synchronous motor of sufficient torque to drive the camera. However, synchronization of rotational speed, so that the camera mechanism completes one cycle for each complete cycle of the power frequency, is not enough, it is also necessary to ensure that the camera shutter is open during the particular half cycle that the tube is energized. Fortunately, the armature of a synchronous motor, when in step with the power frequency, has certain reproducible angular positions corresponding to the zero points of the power line alterations. The number of these for any given motor depends upon its rated speed. A 3,600 rpm (60 rps) motor will have two cycle points 180 degrees apart, and a 1,800 rpm (30 rps) motor will have four 90 degrees apart, etc. By coupling the motor so that the camera shutter will be open to concur with the energy pulse of the power frequency, the first of the synchronization problems is solved. Every time the motor attains synchronization, the proper relationship of the camera shutter to the zero points of the power cycle will be achieved.

Opening of the camera shutter may occur, however, during either of the half cycles of the alternating current wave, and there is no simple way to ensure that the seating of the motor will concur with the energization periods of the x-ray equipment. It is therefore necessary to label



Fig 1 Commutator on synchronous motor. Pencil points to small insulated segment which causes an interruption of the circuit. This is seen as a break in the sine wave on the oscilloscope.

the power cycles in some way, and to provide a means of changing the relative position of the open phase of the camera shutter to correspond. In our apparatus, a commutator (Fig 1) on the motor shaft, bearing an insulated segment which passes under a brush during the time that the shutter is open, is used to interrupt the low-voltage alternating current supply to the vertical plates of a cathode ray oscilloscope which is adjusted to show one complete cycle upon its screen (Fig 2). This interruption produces a break in the smooth sine wave of one of the half cycles seen on the screen, thus labeling it as the one during which the shutter is open. By experiment, it has been determined which one of these corresponds to the half cycle energizing the tube. If the shutter opening occurs in the proper half cycle, exposure can begin at once. If it does not

occur in the proper half cycle, it is necessary to shift the angular position of the shutter opening until the proper relationship is obtained. This can be done by interrupting the power supply to the motor for a short period in the hope that, when the motor again comes into step, it will be in the proper angular phase. This is the method which we first used, but since several trials were frequently necessary to establish the proper synchronization, and since at 60 frames per second approximately 4 feet of film pass through the camera per second, this method resulted in a waste of film. A system was therefore devised which permitted the relative angular position of the camera drive to be shifted quickly through an angle of 180 degrees with reference to the motor shaft while at full speed. This permits positive synchronization of the camera shutter with the proper half cycle of the power alternation without great delay and has effected a considerable saving of film.

Starting the camera drive motor has also presented a problem. The particular motor used is designed for use on a 220-volt supply, and can be started on this full voltage. When this is done, however, the motor accelerates to full speed very rapidly (in a fraction of a second) and it was feared that this rapid acceleration would break the film or possibly damage the camera mechanism. For this reason, a semi-automatic system of reduced-voltage starting was adopted, in which about 70 volts is first applied to the motor to start its rotation. This is gradually increased by a variable transformer to 110 volts, at which voltage the motor will run near full speed, though not in reliable synchronization. Switches then automatically disconnect the 110-volt supply and apply a full 220 volts to the motor, at which time it comes into step and is ready for use.

When this system is in proper synchronization, the camera shutter is open for $1/127$ second, during which time an x-ray impulse occurs and the film remains stationary. The shutter then closes and remains closed for $1/113$ second, during

which time the film is moved to the next frame and there is no x-ray output. For a three-second run that results in the production of 180 images and uses $11\frac{1}{4}$ feet of film for the actual recording of the images, another 8 feet of film are wasted in starting the camera and about 4 feet are lost in stopping.

With a synchronous motor camera drive, it is possible to use reduction gears to slow the camera speed. With the proper gear reduction, a rotary circuit breaker may be used to interrupt the primary circuit of the high-tension transformer in phase with the power frequency in the manner of an impulse timer. This will permit the use of lower camera speeds (at any sub-multiple of 60 frames per second) and retain the advantages of synchronization of shutter opening with x-ray output.

It has been found necessary to protect the film magazine with lead, but the several elements in the lens seem to provide ample protection from radiation during the time the film is in or passing through the shuttle.

X-Ray Technical Factors A DuPont-Patterson E-2 fluoroscopic screen and Kodak Linagraph Ortho film, 35-mm (green sensitive) are utilized. The x-ray generator employed is the KX-1 and the x-ray tube is a CRT 1-2, both manufactured by the General Electric X-ray Corporation. This generator has ample capacity for all types of cinefluorographic work. The valve tubes are air-insulated and any pair may be readily removed to convert the generator to half-wave rectification. With the approval of the manufacturer, the CRT x-ray tube was used above its rated capacity, and has been adequate for all our requirements.

One hundred kilovolts is a constant factor for all exposures, and the milliamperage is varied from 75 for thin parts to 150 for areas of greater opacity. At 100 kilovolts the tube with an added filter of 1 mm of aluminum gives a half value layer of 2 mm of aluminum and an estimated threshold erythema of 350 r. The tube output, at 150 ma at a distance of 24 inches, is ± 5 r per second measured

in air The target-screen distance utilized is altered from 29 to 50 inches, depending on the thickness of part and whether or not a stationary grid is employed When the maximum camera speed of 60 frames per second is used, these radiographic factors permit the recording of adequate densities for all parts of the body except the trunk below the diaphragm in adults

Film Processing For the cinefluorographic process to be as efficient as possible, it is most important that optimum speed and contrast be obtained in the final record Hence, it is essential that one use the most favorable processing procedures—those recommended by the manufacturer Actually, to make the most of the minimum exposures obtained, we develop the film to a very high gamma The necessity for attention to these details cannot be over-emphasized Experience has shown that, despite the use of entirely suitable technical arrangements and exposure factors, it is all too easy to produce records of poor technical quality because of careless or incorrect film processing

PROTECTION OF TECHNICAL PERSONNEL

The personnel operating our cinefluorographic equipment is carefully monitored by film badges and pencil electrometers under the supervision of a physicist At no time has anyone received a daily dose greater than 0.05 r This is made possible by the fact that the complete procedure can be carried out by a single technician and that, as a rule, patients are selected who can co-operate fully During cinefluorography the technician and any medical or nursing personnel present stand behind an adequate protective barrier

DOSAGE

It has been difficult to gain any definite ideas from the literature as to the dosages employed in previously published cinefluorographic work Stewart, whose technical factors produced an erythema in forty-eight seconds, limited his exposures to five seconds per examination Some investigators have used doses as high as a



Fig 2 Sixty-cycle sine wave on oscilloscope, showing break in upper half of wave Each half of wave represents one impulse (1/120 second)

full erythema, without apparent concern Nor is it easy to arrive at a conclusion, from the general literature, as to what really constitutes a tolerance factor to radiation injury for a single exposure In our work, the protection of the patient from undue dosage of radiation is given careful and constant consideration At the outset we decided to keep the exposures as close to the range commonly utilized for routine radiographic examinations as possible, and to limit the amount of radiation reaching the skin to a small fraction of a skin erythema dose

As a preliminary step, a radiologic history is obtained with particular attention to such factors as possible employment of the patient in radiation laboratories and the amount of radiation that may have been received during diagnostic x-ray examinations or x-ray therapy At first

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SUMARIO

Cinefluorografía Repaso Periódico de los Problemas Técnicos, Factores Posológicos e Impresiones Clínicas

Aparacen aquí descritas la instalación y las técnicas que emplean para cinefluorografía en el Departamento de Radiología de la Facultad de Medicina y Odontología de la Universidad de Rochester, N Y Se utilizan películas de 30 mm, habiéndose alcanzado una velocidad de sesenta exposiciones por segundo Los problemas técnicos planteados por el procedimiento fotográfico son discutidos Los factores radiográficos empleados son 100 kv, 75 a 100 ma, según el espesor de la parte en estudio, 1.0 mm de filtro de aluminio, dando una capa de hemirreducción de 2 mm de aluminio, distancia foco-piel de 72.5 cm a 1.25 m Cuando se utiliza la máxima velocidad de la cámara de 60 exposiciones por segundo, esos factores permiten registrar densidades adecuadas para todas las partes del cuerpo, exceptuando, en los adultos, el tronco más abajo del diafragma La exposición usada en cualquier examen aislado no

pasa de un máximo de 25 r, haciéndose todo esfuerzo para rebajarla a 15 r o menos, si es posible

Para la impresión se prefiere la película de 16 mm, por razones de conveniencia y economía en la proyección y el manejo

El lento movimiento que facilitan las películas obtenidas a razón de 60 exposiciones por segundo resulta en particular ventajoso en el estudio de los procesos que entrañan movimientos rápidos, como en los estudios de la acción cardíaca, el movimiento de los tejidos pulmonares y el pase de medios opacos a través del tubo digestivo y de los vasos sanguíneos A los AA también les ha resultado útil en el campo de la cirugía ortopédica

Los aparatos elaborados en la Universidad de Rochester pueden ser duplicados para uso general, pues todas las piezas se hallan de venta en el comercio

Heart Measurement

A Simplified Method¹

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RECENTLY HODGES (1) and Schwarz (2) have described in this Journal the technical details and nomograms that have been used in this laboratory for determining heart size in the teleroentgenogram, either from planimeter measurement of frontal plane area or from linear measurement of the long and short diameters of the frontal plane silhouette. In both instances, several steps were involved in finally obtaining heart size expressed in percentage variation from normal.

The purpose of this paper is to see how far one can go in simplifying heart measurement in adults without any significant loss in accuracy. It became apparent that, in order to attain this objective, three things would be desirable:

(1) To eliminate calculation of divergent distortion for each individual patient and, instead, obtain an average distortion factor which could be applied to all subjects.

(2) To avoid making an outline of the complete cardiac silhouette, using only those borders which can be seen on the chest film.

(3) To combine in one nomogram the equation for predicting normal size with the equation for measured size in such a way that percentage variation from normal could be read directly.

In order to obtain an average divergent distortion factor, one must always take the chest film in the same manner, preferably at a distance where divergent distortion is reduced to a minimum consistent with a reasonable exposure time. Since our routine chest films have been taken at a 72-inch target-film distance with the anterior chest surface closest to the film,

and since this is also the common practice elsewhere, it was selected as my standard technic. The only variable then is the distance of the heart from the film, a factor which varies with the anteroposterior diameter of the chest. To determine if variation in divergent distortion between subjects was really significant, 100 adult patients were selected at random, with wide differences in height, weight, and heart size, as shown in Tables I to V. The divergent distortion correction factor was figured individually, based on the anteroposterior chest diameter of each patient, and the result was recorded. The average divergent distortion correction factor was 0.89, obtained by adding the individual correction factors together and dividing by 100. The range extended from only 0.87 to 0.91, despite the fact that anteroposterior chest diameters varied from 16.5 cm to 29 cm. Therefore, the greatest possible deviation from the average or mean is about 2 per cent of the total frontal plane area, an insignificant figure.

As the next step in simplification, one would like to avoid making a tracing of the complete cardiac outline, particularly since the upper and lower borders are drawn empirically. The product of the long and short diameters multiplied by a correction factor will give a reasonable approximation of frontal plane area. In order to avoid drawing the empiric upper and lower heart borders, I measure the long diameter, L , from the junction of the right heart border and great vessels to the cardiac apex, and the short diameter, S , from the junction of the left heart border and pulmonary conus to the right cardiophrenic angle (Fig. 1). These two diameters, as a

¹ From Division of Roentgenology, The University of Chicago, Chicago, Ill. Accepted for publication in April 1948.

TABLE I NORMAL HEARTS ($\pm 10\%$)

X-ray or Unit No	Height (cm)	Weight (kg)	AP Chest Diameter (cm)	Planimeter Method			Diameter Method				Pre- dicted Area (sq cm)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq cm)	Divergent Distortion Correction Factor	Net Area (sq cm)	Long Diameter (cm)	Short Diameter (cm)	L X S*	Agp/L X St	Net Area (sq cm)		
U 413 123	151	64.5	22.0	108	0.89	96	13.5	10.4	140.4	0.709	95	+8	+6
82,006	162	55.4	20.0	111	0.90	100	13.4	10.9	146.0	0.700	99	+4	+3
79,594	173	87.4	24.0	146	0.88	128	14.9	12.6	187.7	0.777	127	+10	+9
80,625	171	54.4	18.5	108	0.90	97	12.7	11.8	150.0	0.720	101	-6	-2
116,981	170	68.4	21.5	122	0.89	109	13.9	11.6	161.0	0.757	109	+2	+2
116,996	172	56.8	19.0	114	0.90	103	13.8	10.7	148.0	0.770	100	-2	-5
116,982	181	81.0	23.5	140	0.89	125	15.1	12.8	193.0	0.726	131	+2	+6
116,997	155	49.5	18.0	97	0.90	87	11.9	10.5	125.0	0.776	85	0	-2
116,998	157	63.6	25.0	107	0.88	94	13.1	10.7	140.0	0.764	95	0	+1
116,993	167	58.6	21.0	122	0.89	109	13.6	11.8	160.2	0.761	109	+7	+7
116,995	160	66.0	20.0	118	0.90	106	13.6	11.3	153.8	0.767	104	+8	+6
116,980	164	59.0	20.5	110	0.90	99	12.8	11.2	143.4	0.766	97	0	-2
122,915	173	76.6	22.5	133	0.89	118	13.8	12.6	174.0	0.764	118	+5	+5
117,037	177	73.6	21.0	136	0.89	121	14.9	12.1	180.0	0.755	122	+5	+6
117,029	147	47.6	16.5	94	0.91	86	12.2	10.3	125.8	0.748	85	+8	+6
117,024	177	76.5	22.0	145	0.89	129	14.8	13.2	195.0	0.744	132	+10	+13
116,991	157	58.2	21.0	114	0.89	101	13.5	10.9	147.0	0.775	100	+8	+7
116,990	166	59.0	21.0	108	0.89	96	12.8	11.1	142.0	0.760	96	-4	-1
116,999	157	59.0	19.0	99	0.90	89	12.3	10.4	128.0	0.773	86	-3	-6

For explanatory details, see Table V, page 696

TABLE II SLIGHTLY ENLARGED HEARTS (+11% TO +25%)

TABLE II. SLIGHTLY ENLARGED HEADS (1 1/2 to 1 3/4 to 2 1/4)														
X-ray or Unit No	Height (cm)	Weight (kg)	AP Chest Diameter (cm)	Planimeter Method			Diameter Method					Pre-dicted Area (sq cm)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq cm)	Divergent Distortion Correction Factor	Net Area (sq cm)	Long Diameter (cm)	Short Diameter (cm)	L X S*	Agp/L X St	Net Area (sq cm)			
U 412,736	155	51.3	22.0	119	0.89	106	13.7	11.3	155.0	0.767	105	88	+20	+19
132,470	177	76.0	23.0	146	0.89	130	15.5	13.1	203.0	0.719	137	116	+12	+18
125,269	170	55.0	19.5	143	0.90	129	15.5	12.6	195.0	0.733	132	103	+25	+28
115,605	151	60.6	26.0	120	0.88	106	13.2	11.9	157.0	0.764	106	88	+20	+14
83,027	172	70.0	20.5	142	0.89	127	15.3	12.2	186.6	0.761	126	110	+15	
59,967	183	82.5	26.5	165	0.88	145	15.6	13.3	208.0	0.793	140	123	+18	+14
21,016	167	65.0	18.5	137	0.90	123	14.8	12.2	180.5	0.759	123	103	+20	+20
52,651	163	62.4	19.0	130	0.90	117	14.0	11.9	166.5	0.780	113	99	+18	+14
127,649	171	96.0	27.5	151	0.87	131	15.5	12.5	194.0	0.778	131	118	+11	+11
99,227	180	82.0	21.5	156	0.89	139	15.8	13.2	208.5	0.746	141	121	+15	+16
79,711	165	79.7	26.0	143	0.88	126	15.8	12.4	196.0	0.730	133	107	+18	+24
79,093	170	64.0	19.5	145	0.90	131	15.4	12.7	195.7	0.740	133	106	+24	+25
77,939	160	51.2	17.5	121	0.90	109	13.8	11.9	164.4	0.735	111	93	+17	+19
80,785	185	79.6	21.0	171	0.87	149	17.3	13.2	238.0	0.718	155	124	+20	+25
87,606	153	54.5	20.5	115	0.90	103	13.5	11.8	159.0	0.723	108	87	+18	+23
77,880	163	66.2	20.5	128	0.89	114	13.7	12.4	170.0	0.753	115	99	+15	+16
76,727	175	73.0	19.0	158	0.90	142	15.5	12.8	198.0	0.798	134	113	+25	+18
111,293	171	67.3	20.5	132	0.90	119	15.3	11.5	176.0	0.750	119	107	+11	+11
117,088	167	52.0	20.0	132	0.90	119	14.5	11.8	171.0	0.772	116	99	+20	+17
122,019	154	54.4	18.0	110	0.90	99	12.8	11.3	144.7	0.760	98	89	+11	+10
122,245	175	61.0	20.5	133	0.91	121	14.5	12.5	181.2	0.734	123	109	+11	+12
122,795	171	68.1	21.5	146	0.89	130	15.5	12.4	192.2	0.759	130	108	+20	+20
116,975	178	46.0	19.0	134	0.90	121	14.4	12.9	185.8	0.721	126	106	+14	+19
88,146	158	69.0	24.5	129	0.88	114	13.8	12.2	168.2	0.766	114	97	+18	+18
80,068	150	56.3	21.5	120	0.89	107	14.2	11.3	160.5	0.747	109	86	+24	+26
138,647	171	76.4	20.0	145	0.90	130	14.8	12.8	189.5	0.765	128	111	+17	+15
403,644	162	61.5	20.5	127	0.90	114	15.6	10.8	168.5	0.753	114	98	+16	+16
396,443	174	61.2	19.5	150	0.90	135	15.1	13.8	204.0	0.735	138	108	+25	+28
116,994	167	60.5	19.5	139	0.90	125	14.8	12.4	183.5	0.757	125	102	+23	+23

For explanatory details, see Table V, page 696

TABLE III MODERATELY ENLARGED HEARTS (+20% TO +50%)

N Unit No	Height (cm)	Weight (kg)	AP Chest Diameter (cm)	Planimeter Method			Diameter Method					Pre- dicted Area (sq cm)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq cm)	Divergent Distortion Correction Factor	Net Area (sq cm)	Long Diameter (cm)	Short Diameter (cm)	L × S*	Agp/L × St	Net Area (sq cm)			
128,032	183	79.0	24.5	187	0.88	165	17.8	13.7	214.0	0.706	165	122	+35	+35
124,087	188	58.0	18.5	135	0.90	121	15.3	11.7	170.0	0.754	121	93	+30	+30
122,442	163	55.4	19.0	160	0.90	114	17.0	11.9	200.5	0.797	136	97	+19	+40
82,804	160	68.6	20.0	149	0.90	131	15.6	13.1	201.2	0.729	138	99	+35	+39
79,986	156	55.0	18.0	128	0.90	115	14.6	11.2	163.5	0.782	111	90	+27	+23
70,056	150	59.0	20.0	135	0.89	120	14.5	12.4	180.0	0.750	122	87	+38	+10
80,695	176	89.0	25.5	184	0.88	162	18.0	13.1	211.0	0.766	163	120	+35	+36
78,542	172	60.8	19.0	163	0.90	147	16.1	12.7	201.5	0.797	139	106	+38	+31
78,400	164	60.0	20.0	139	0.89	124	14.9	13.3	183.1	0.755	121	90	+38	+38
79,052	150	70.0	25.5	131	0.88	115	15.0	11.3	169.5	0.773	115	90	+28	+28
80,892	174	92.8	22.0	165	0.89	117	16.7	13.0	217.0	0.760	147	109	+35	+35
78,093	177	92.0	27.5	183	0.87	159	18.2	12.1	220.0	0.831	150	121	+31	+24
77,808	156	75.0	22.5	138	0.89	124	14.3	12.5	179.0	0.771	121	97	+28	+25
73,621	154	47.0	20.0	131	0.90	118	11.3	11.6	166.0	0.788	113	86	+37	+31
78,550	163	61.0	22.0	151	0.89	131	15.2	12.9	196.0	0.770	133	98	+37	+36
80,449	167	56.6	19.5	143	0.90	129	11.8	13.3	197.0	0.725	133	101	+27	+32
122,115	170	79.6	21.0	162	0.89	144	15.2	13.7	201.1	0.793	141	111	+30	+27
85,638	144	68.0	20.0	136	0.87	118	11.1	12.1	178.5	0.761	121	85	+39	+42
J 399,620	160	67.8	24.0	149	0.88	131	15.1	12.3	189.5	0.785	128	98	+33	+31
98,196	160	58.0	24.0	155	0.88	136	17.5	11.6	203.0	0.763	138	95	+43	+45
J 397,113	180	91.7	26.5	183	0.88	161	16.9	11.7	218.2	0.737	169	121	+30	+36
J 414,029	173	61.5	23.0	171	0.89	152	16.7	13.6	227.0	0.753	151	107	+12	+13
53,777	158	53.6	18.0	136	0.90	122	14.5	11.8	171.0	0.705	116	92	+33	+26
J 420,711	162	51.0	19.5	127	0.88	111	14.8	11.0	162.8	0.780	110	86	+33	+28
J 399,938	157	63.2	25.0	143	0.88	126	15.1	12.7	195.5	0.731	133	91	+31	+11

For explanatory details, see Table V, page 696

TABLE IV MARKEDLY ENLARGED HEARTS (+51% AND OVER)

TABLE IV MARKEDLY ENLARGED HEARTS (+51% AND OVER)														
X ray or Unit No	Height (cm)	Weight (kg)	AP Chest Diameter (cm)	Planimeter Method			Diameter Method					Pre- dicted Area (sq cm)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq cm.)	Divergent Distortion Correction Factor	Net Area (sq cm.)	Long Diameter (cm)	Short Diameter (cm)	L X S*	Agp/L X St	Net Area (sq cm.)			
130,401	169	58 0	20 0	225	0 90	202	19 1	16 2	309 7	0 726	210	103	+95	+103
129,020	154	81 4	27 5	194	0 87	169	18 0	13 8	248 2	0 787	169	98	+73	+73
130,221	172	84 4	25 5	213	0 88	187	18 8	15 3	287 8	0 746	195	115	+63	+69
117,839	163	62 0	21 0	189	0 89	168	17 6	14 0	246 0	0 768	167	98	+71	+70
122,709	171	90 5	27 5	212	0 87	184	18 2	15 6	284 0	0 746	192	116	+59	+65
120,189	172	71 5	22 0	223	0 89	198	19 9	15 1	300 6	0 809	204	110	+80	+85
120,433	166	62 0	21 0	203	0 89	181	19 0	14 2	270 0	0 752	183	101	+79	+81
121,459	166	70 8	23 0	240	0 89	214	20 5	16 6	340 0	0 706	230	105	+104	+119
119,288	150	70 0	24 0	186	0 89	166	18 4	13 6	250 0	0 744	170	90	+84	+88
77,410	173	72 5	24 0	211	0 88	186	18 8	14 9	280 0	0 764	190	111	+68	+70
79,479	147	51 8	22 0	157	0 89	140	16 3	11 9	194 0	0 809	132	82	+70	+62
79,565	160	65 0	24 0	170	0 88	150	17 1	12 2	208 2	0 816	141	97	+55	+45
119,229	173	79 7	25 5	243	0 88	204	19 9	15 3	304 2	0 799	207	114	+88	+81
122,395	159	56 0	22 0	268	0 89	239	19 7	18 4	362 2	0 740	246	93	+157	+162
88,718	153	46 5	21 0	153	0 89	136	14 8	14 0	207 5	0 737	141	85	+60	+65
118,601	178	86 2	26 0	314	0 88	276	22 0	17 3	380 7	0 824	258	120	+130	+115
77,649	170	57 2	19 0	204	0 90	184	19 2	13 7	263 5	0 775	178	104	+77	+71

For explanatory details, see Table V, page 696

TABLE V UNDERSIZED HEARTS (-11% OR LESS)

X-ray or Unit No	Height (cm)	Weight (kg)	AP Chest Diameter (cm)	Planimeter Method		Diameter Method				Pre- dicted Area (sq cm)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq cm)	Divergent Distortion Correction Factor	Net Area (sq cm)	Long Diameter (cm)	Short Diameter (cm)	L X S* Agp/L X St†	Net Area (sq cm)		
113,351	171	67.5	22.0	107	0.89	95	12.8	11.2	143.5	97	108	-10
123,057	187	65.0	21.0	101	0.89	90	12.5	11.0	137.5	93	121	-24
98,623	185	94.0	24.0	128	0.88	113	13.9	12.3	0.748	116	129	-10
78,027	178	53.4	21.0	102	0.89	91	13.7	10.7	146.5	99	109	-9
77,682	174	66.0	22.0	100	0.89	89	13.1	9.9	0.771	88	110	-20
77,587	175	62.3	18.5	91	0.90	82	12.3	10.0	123.0	83	110	-24
117,018	151	118.0	27.0	107	0.87	93	13.4	9.5	127.2	86	108	-20
117,005	174	63.6	21.0	108	0.89	96	13.9	10.6	147.5	100	109	-9
117,041	167	64.3	20.5	101	0.89	90	13.0	10.7	139.0	94	103	-13
116,974	157	67.3	21.0	90	0.89	80	12.0	9.4	112.8	76	96	-20

Explanation of Tables I-V

One hundred adult chest films were selected at random and the hearts were divided into five groups according to their size. All were measured independently by two methods: (1) a planimeter tracing of the complete cardiac silhouette, (2) the long and short diameter method employing the nomogram illustrated in the text.

When the planimeter method was used, the divergent distortion correction factor was figured individually for each patient. These correction factors formed the basis for calculating the average divergent distortion correction factor used in the construction of the nomogram.

The factor which, when multiplied by the product of the long and short diameter, would yield frontal plane area, was obtained from the formula $\text{Agp/L} \times \text{S}$. The average factor used in making the nomogram was obtained by adding the correction factors calculated for each case and dividing by 100. This was 0.760. By the same method, this factor was calculated for each size of heart. The factors were as follows:

Normal hearts	±10%	(19 cases)	0.760
Slightly enlarged hearts	+11 to +25%	(29 cases)	0.752
Moderately enlarged hearts	+26 to +50%	(25 cases)	0.768
Markedly enlarged hearts	+51% and over	(17 cases)	0.767
Undersized hearts	-11% and under	(10 cases)	0.753

The variation in the correction factor for each category of heart size was not regarded as significant.

* Long diameter (in cm) multiplied by short diameter (in cm)

† Gross cardiac area measured by the planimeter divided by the product of the long and short diameters.

rule, are approximately perpendicular to each other, but no attempt is made to assure that relationship²

In order to obtain the correction factor for the product of $L \times S$, which would yield frontal plane area, it was necessary to draw the complete heart outline so that it could be traced with a planimeter. The product of $L \times S$ was compared with the planimeter measurement of the cardiac area to obtain a correction factor which would make them equal according to the formula

$$\frac{\text{Planimeter measurement of cardiac area in sq cm}}{\text{Long diameter in cm} \times \text{short diameter in cm}} = \text{correction factor}$$

The 100 cases presented in the tables formed the basis for this comparison. The correction factor for all cases taken together was 0.760. Hence, the resulting equations will be

- (1) $L \times S \times 0.760 = A_g$
- (2) $L \times S \times 0.760 \times 0.89 = A$, or
 $L \times S \times 0.676 = A$

where

L = long diameter of heart shadow
 S = short diameter of heart shadow
 A_g = gross frontal plane area
 A = net frontal plane area

With the solution of the first two problems, it was comparatively easy to construct a single nomogram which would combine the equations for predicting normal size and measured size in such a way that percentage variation from normal could be read directly. In my nomogram (Fig 2) the scales for long and short diameter are curved according to the formula of a parabola ($y = ax^2$) in order to make the scale for net frontal plane area arith-

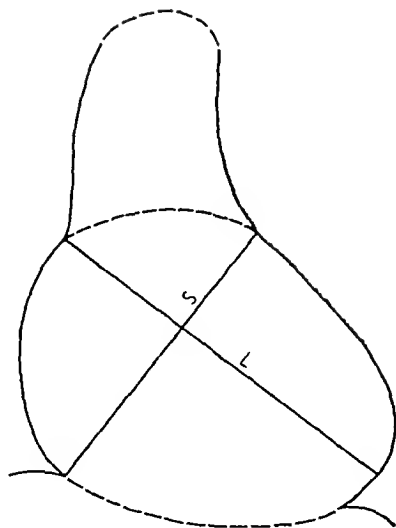


Fig 1 Complete cardiac silhouette, showing how the long and short diameters are drawn. In actual practice the measurements are made directly on the chest film, since the heart shadow is not traced, the empiric upper and lower borders are omitted (broken lines).

The long diameter, L , is drawn from the right cardio-vascular junction to the left apex. The short diameter, S , is drawn from the junction of left heart border and pulmonary conus to the right cardiophrenic angle.

metic. The net frontal plane area scale would be logarithmic if the long and short diameter lines were vertical and straight. The scale for net frontal plane area must be arithmetic to compare with the arithmetic scale of predicted area obtained from the height and weight according to the formula of Hodges and Eyster (3), $0.87H + 0.34W - 63.8$, where H = subject's height in cm and W = weight in kg. The slope and position of the center scale for percentage variation from normal is obtained by connecting with a straight line the zero points of the scales for net and predicted frontal plane area.

Of course, this same combination of equations for measured and predicted area accounts for the curvature of the diameter scales in the chart of Ungerleider and Gubner (4). My chart differs from

² It is recognized that the point of maximum extension of the heart to the right occasionally appears to lie below the cardiohepatic angle, being lost in the shadow of the diaphragm. However, even in those few cases, it was surmised how little difference it made in the actual measurement of the short diameter when the lower empiric border of the cardiophrenic angle. Usually the difference was less than one or two millimeters, sometimes none. If the diaphragm is high, either because of expiration or some pathologic condition, more of the heart shadow would be obscured and increase the error. No matter what method is used, the chances of error are great when much of the heart is hidden by the diaphragm. It would be best to avoid cardiac mensuration in those cases entirely.

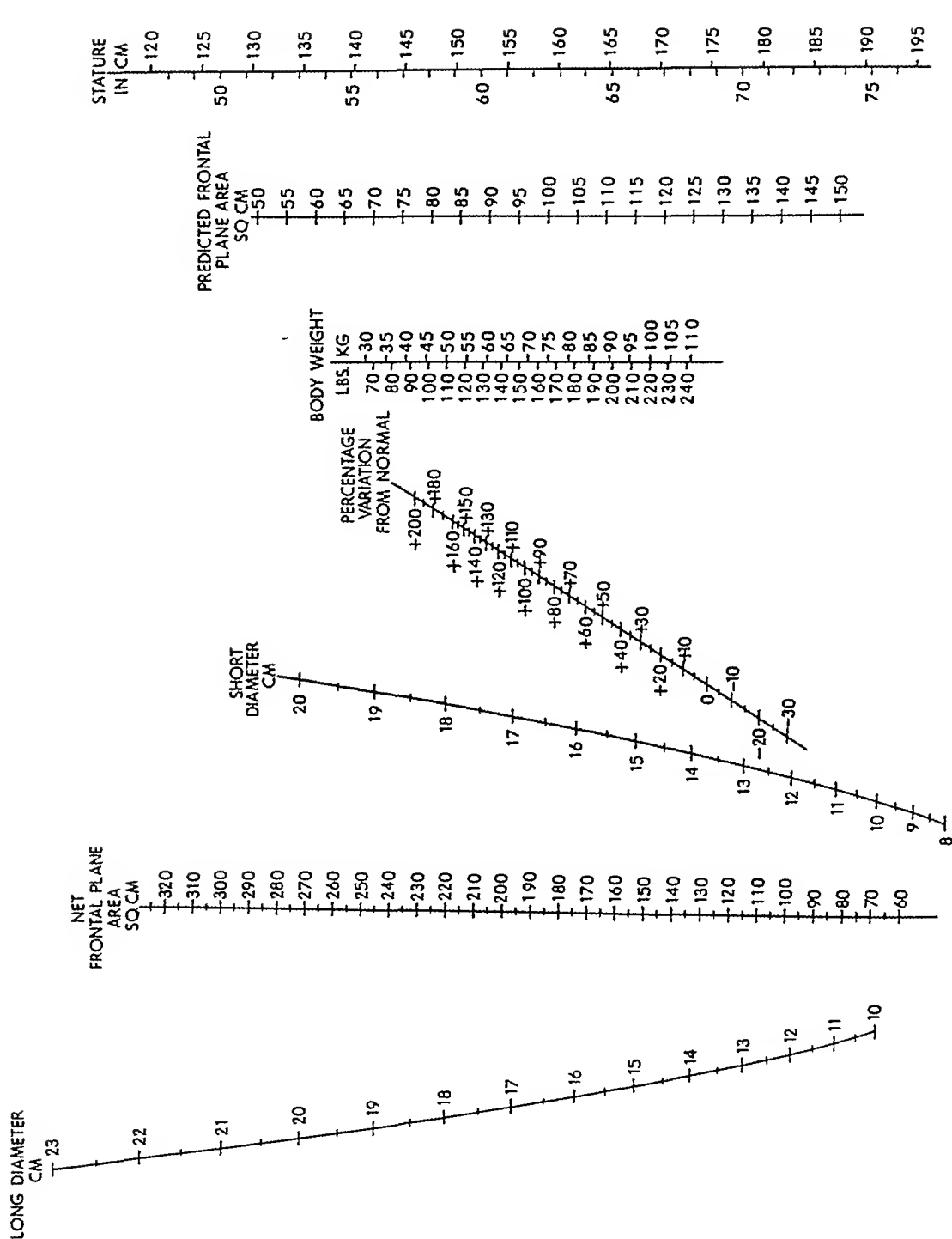


Fig 2 Heart size nomogram For explanation, see foot of opposite page

theirs chiefly in covering a wider range of heart size and providing a scale from which percentage variation from normal may be read directly

In actual practice, we select the larger of the heart shadows in a set of stereoscopic chest films. However, seldom is there any significant difference in the heart size between the two films. Points from which the diameters are drawn are marked with a wax pencil on the chest film selected, the long and short diameters are measured with a transparent centimeter ruler. These values are transferred to the nomogram, the ruler is placed across the curved scales for long and short diameter, the net frontal plane area being read where the ruler intersects that scale. The ruler is then placed across the scales for body weight and stature, the predicted frontal plane area is read where the ruler intersects that scale. Finally, the ruler is so placed that it connects the values for net and predicted frontal plane area, the percentage variation from normal being read from the sloping center scale at the point intersected by the ruler. A heart which measures between ± 10 per cent is considered within normal range.

In order to use the nomogram accurately, the following conditions should be met

(1) The subject should be an adult seventeen or more years old, younger only if the stature exceeds 170 cm

(2) The chest roentgenogram should be taken with the anterior surface of the patient's chest closest to the film

(3) The target-film distance should be 72 inches

SUMMARY

1 For the computation of heart size from chest roentgenograms without planimetry and without empirical completion of the upper and lower borders of the silhouette, the following equation is offered

$$A = L \times S \times 0.676$$

where

A = the frontal plane area of the heart in sq cm

L = length in cm of its long axis

S = length in cm of its short axis

2 A seven-scale nomogram solves the equation and expresses heart size in percentage variation from normal

NOTE I would like to thank Dr Paul C Hodges, Chief of the Division of Roentgenology, University of Chicago, for his invaluable suggestions in the preparation of the manuscript, and Mr Herman Rubin, Research Associate of the Cowles Commission for Research in Economics, for his assistance in construction of the nomogram

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Explanation of Nomogram

☐ The nomogram is applicable only to adults seventeen years old or older. It can be used for younger subjects only if the stature exceeds 170 cm. The chest roentgenogram should be taken with the anterior surface of the chest closest to the film at a target-film distance of 72 inches.

The long and short diameters are measured directly on the chest film. The values are transferred to the nomogram; a straight edge ruler is placed across the scales for *long* and *short diameters* and the *net frontal plane area* read where the ruler intersects that scale. Next the ruler is placed across the scales for *body weight* and *stature* and the *predicted frontal plane area* is read where the ruler intersects that scale. Finally the ruler is placed so that it connects the values for *net* and *predicted frontal plane area*; the *percentage variation from normal* being read on the sloping center scale at the point intersected by the ruler.

Photostatic copies of this nomogram, 14 X 17", may be obtained from the University of Chicago Bookstore, 5802 Ellis Avenue Chicago 37 Illinois at \$1.50 each.

(For Spanish Summary, see following page)

SUMARIO

Medición del Corazón Técnica Simplificada

Para computar el tamaño del corazón por las radiografías torácicas sin planimetría y sin completar empíricamente los bordes superior e inferior de la silueta, ofrécese la siguiente ecuación

$A = L \times S \times 0.676$
en la que

A = área plana frontal del corazón en cm^2

L = largo en cm del eje largo

S = largo en cm del eje corto

Un nomograma de siete escalas resuelve la ecuación y expresa el tamaño del corazón en variación porcentual de lo normal



The Retrogastric Space, Roentgenographically Considered¹

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THIS STUDY was undertaken in an attempt to clarify certain aspects of the diagnosis of retrogastric masses by roentgenographic methods. In several routine cases of suspected retrogastric mass, when a clear-cut extrinsic pressure defect on the posterior border of the barium-filled stomach was not demonstrated, a great deal of speculation was aroused concerning the significance of the distance from the posterior stomach border to the anterior border of the adjacent vertebral bodies.

The literature is devoid of studies that might serve as a background for the theoretical "normal retrogastric space." Engel and Lysholm made exposures of patients in the prone-lateral position and demonstrated an impression on the posterior stomach wall which was interpreted as being caused by pancreatic pressure. In their cases without pancreatic disease, they stated that this impression was about the width of the adjacent vertebral body. Rendich, Poppel, and Cove quote Butler and Ritvo, as well as Rigler, as having stated that the stomach is displaced upward and forward by retrogastric masses. Volpe demonstrated identical compression of the antrum of the stomach by a hydatid cyst of the liver and by a retroperitoneal tumor, the latter "probably from the pancreas." Poppel and Marshak appreciated the fact that retrogastric masses might be expected to produce a different picture in hypersthenic and hyposthenic individuals. Holt quotes Case's observation that a cyst arising from the tail of the pancreas very frequently produces a smoothly rounded indentation in the greater curvature of the stomach and suggests that the association of such a defect, relatively high on the greater curvature, with anterior displacement of the stomach is strong evidence of

pancreatic cyst. Shanks describes Twinning's method of examination, which called for a lateral roentgenogram of the barium-filled stomach in the supine position.

In the studies cited above, all diagnoses were based on visible impressions upon the posterior gastric wall, and in none, with the exception of that of Engel and Lysholm, was reference made to measurable distance *per se*. In an effort to evaluate the importance of distance alone in the diagnosis of retrogastric masses, and hoping thus to find an aid in the absence of a demonstrable extrinsic pressure effect, we decided to use the left lateral erect exposure in all cases. It was felt that only in such a view would the stomach be seen free of pressure influences that might conceivably alter its true position. The universally accepted fact that the position of the stomach varies with the habitus of the individual was taken into consideration, and our patients were divided into habitus groups.

Ninety-seven unselected consecutive patients with complaints indicative of a high intrinsic gastro-intestinal lesion were examined in the left lateral erect position. The majority had histories suggestive of duodenal ulcer. In none was there any evidence, either objective or subjective, of retrogastric disease. Sixty-seven of the group (approximately 70 per cent) were sthenic in habitus, 16 (approximately 17 per cent) were hypersthenic, and 14 (approximately 13 per cent) were hyposthenic.

In all cases, the stomach was filled with barium in sufficient amount so that the extreme proximal cardia could be clearly visualized. In the hypersthenic and the sthenic group, three measurements were taken: first, from the posterior wall of the cardia to the anterior border of the vertebral body directly opposite, second, from

¹ Accepted for publication in April 1948.

the posterior wall of the pars media to the adjacent vertebral body, third, from the most distal portion of the posterior wall to the adjacent vertebral body. In the hyposthenic group, the anteroposterior diameter of the body of the third lumbar vertebra was also measured, for comparison with the retrogastric distances.

In the tabulation to follow, it will be noted that all designated measurements were made in millimeters. Zero (0) indicates that the posterior gastric wall is either in contact with the anterior border of the adjacent vertebral body or is actually superimposed posteriorly upon it. A dash (—) denotes cases of "transverse stomach" where the posterior wall, in its most distal portion, is at the same horizontal level as the posterior wall of the pars media. In Case 4 the examination was repeated and it is listed again as Case 31.

<i>Sihenic Group</i>				<i>Sihenic Group (Cont)</i>			
Measurements (in mm)				Measurements (in mm)			
First (Cardiac)	Second (Mid Portion)	Third (Inferior)		First (Cardiac)	Second (Mid Portion)	Third (Inferior)	
1	0	4	56	38	0	0	38
2	36	74	125	39	0	51	37
3	0	45	77	40	0	41	84
4	0	15	23	41	0	30	72
5	0	10	27	42	23	50	108
6	0	21	44	43	0	38	61
7	0	54	5	44 †	15	86	132
8	27	139	120	45	0	32	65
9	0	39	71	46	8	30	—†
10	0	77	88	47	11	52	76
11	13	22	50	48	0	53	85
12	7	36	41	49	10	25	38
13	15	44	67	50	0	68	81
14	0	8	44	51	0	69	81
15	0	0	59	52	0	4	21
16	0	23	44	53	31	101	120
17	0	0	24	54	0	49	94
18	0	25	31	55	0	46	92
19	11	16	45	56	0	64	67
20	16	41	53	57	7	71	72
21	0	31	48	58	0	67	70
22	14	48	66	59	11	87	128
23	44	63	80	60	0	72	98
24	14	45	53	61	0	57	71
25	0	47	58	62	0	39	79
26	44	42	26	63	0	22	74
27	13	41	55	64	6	67	96
28	18	50	69	65	0	40	—†
29	0	24	24	66	7	91	115
30	8	27	68	67	0	41	69
31 *	0	29	46				
32	45	49	65				
33	0	24	30				
34	3	44	61				
35	2	44	87				
36	0	30	61				
37	0	50	69				

<i>Hypersthenic Group</i>			
Cardiac	Mid Portion	Inferior	
16	15	48	
0	69	103	
44	79	100	
28	101	125	
0	78	62	
11	55	70	
9	84	72	
27	51	98	
8	64	73	
25	66	68	
26	53	64	
31	81	84	
0	69	83	
12	88	115	
12	69	90	
0	54	116	

<i>Hyposthenic Group</i>			
Cardiac	Mid Portion	Inferior	Lumbar Spine
0	32	62	50
12	81	64	43
0	27	77	36
0	42	83	38
0	12	16	41
0	8	16	35
0	9	23	49
4	13	30	35
0	6	34	40
9	25	39	42
0	15	38	44
13	49	55	37
4	7	55	43
0	26	82	44

* Repeat examination of Case 4

† Patient extremely obese

‡ Transverse stomach

RESULTS

As had been expected, all measurements were greater in the hypersthenic group than in the hyposthenic, indicating that the cardia was most often situated well anterior to the adjacent vertebral body and that the gastric axis was more anterior and generally more transverse than in the

smallest, there was no definite correlation between this measurement and the anteroposterior diameter of the body of the third lumbar vertebra. For the most part the former figure was the greater.

In Case 4, in which, as mentioned above, the examination was repeated and recorded as Case 31, there was a noteworthy differ-

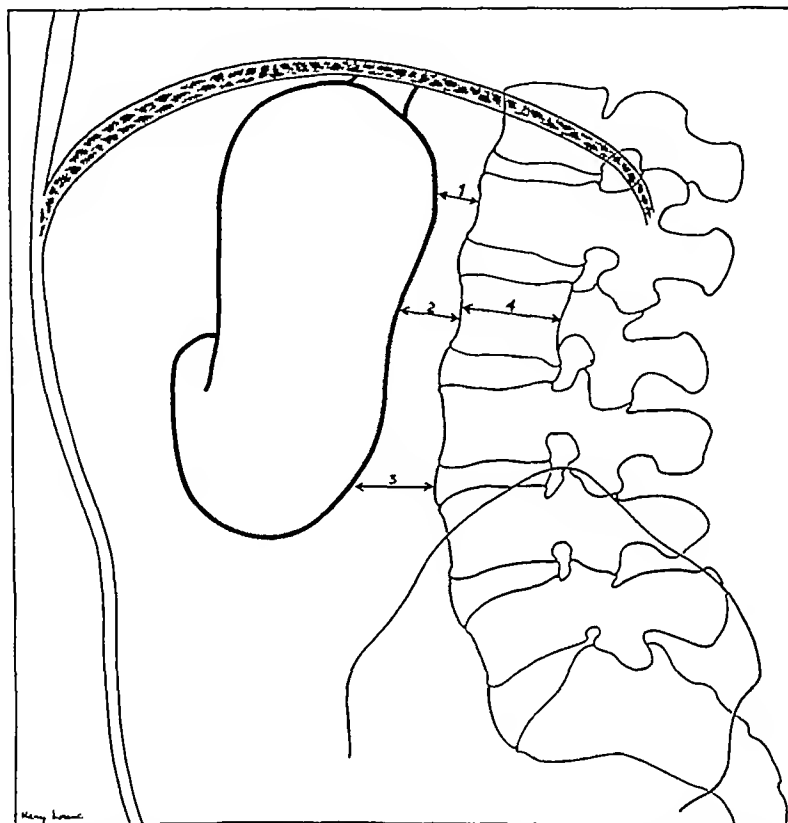


Fig 1 Diagram showing measurements made of the retrogastric space 1 From the posterior wall of the cardia to the anterior wall of the opposite vertebral body 2 From the posterior wall of the pars media to the adjacent vertebral body 3 From the most distal portion of the posterior gastric wall to the adjacent vertebra The anteroposterior diameter of the body of the third lumbar vertebra (4) was also measured in hyposthenic patients for comparison with the retrogastric distances

latter group. The measurements in the sthenic group showed a wide variation between the two extremes represented by the other groups and in some cases even paralleled these figures. Strangely enough, the only two "transverse stomachs" in the series were in sthenic patients.

In cases of the hyposthenic group, in which the third measurement (*i.e.*, from the most distal portion of the posterior wall to the adjacent vertebra) was the

ence in the second and third measurements on the two occasions.

The most frequent impression upon the posterior gastric wall was due to distention of the large bowel in the region of the splenic flexure. This normal impression, which usually is seen in the proximal third of the stomach, must be differentiated from an impression of pathologic origin.

The most striking feature in this study is the complete inconsistency of the meas-

urements in the sthenic group. This observation gains in significance from the fact that the highest percentage of the population falls in this unpredictable group. Furthermore, as demonstrated by Case 4, the stomach is an extremely motile organ and capable of changing its configuration and its axis from moment to moment.

CONCLUSIONS

Roentgen studies of the barium-filled stomach in the left lateral erect position indicate that there is no absolute "yardstick" that can be applied to the retrogastric space for the diagnosis of retrogastric masses. No correlation existed between the retrogastric measurement and the anteroposterior diameter of a representative lumbar vertebral body.

The diagnosis of retrogastric masses depends entirely on the actual demonstration of extrinsic pressure defects in the posterior gastric wall. Since, under normal conditions, a distended splenic flexure may cause such a defect, this must be differentiated from pathological entities. Be-

cause the configuration of the stomach may change from moment to moment, the pressure defect must be proved constant before conclusions as to its significance are drawn.

NOTE: The authors wish to express their thanks to Dr. Lewis J. Friedman, who, as Chief of the Department, extended his fullest cooperation.

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SUMARIO

El Espacio Retrogástrico Considerado Roentgenográficamente

Los estudios roentgenológicos del estómago lleno de bario en la posición erecta lateral izquierda indican que no hay escala absoluta que pueda aplicarse al espacio retrogástrico para el diagnóstico de las tumefacciones allí presentes. No se observó correlación alguna entre el resultado de la medición retrogástrica y el diámetro anteroposterior de un típico cuerpo vertebral de la porción lumbar.

El diagnóstico de las tumefacciones retrogástricas se basa en absoluto en el

hallazgo real de nichos debidos a la presión extrínseca en la pared posterior del estómago. Como normalmente la distensión de la flexura esplénica puede ocasionar uno de esos nichos, hay que diferenciarla, de las entidades patológicas. Dado que la configuración del estómago puede cambiar de momento en momento, hay que demostrar la constancia del nicho de compresión antes de sacar conclusiones en cuanto a su significado.

Mediastinal Emphysema Occurring During an Acute Paroxysm of Bronchial Asthma¹

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MEDIASTINAL emphysema is being recognized with greater frequency, and its clinical and roentgen features are now well established. There are many exciting factors, bronchial asthma being one of the less frequent. Schwartz (1), in 1945, was able to collect from the literature 25 cases of mediastinal and subcutaneous emphysema occurring as a complication of bronchial asthma, and added one case of his own. Since that time (through 1946) two more cases have been reported (2, 3). A case is now being presented to record this phenomenon in the roentgen literature.

Macklin and Macklin's theory for the production of mediastinal emphysema is generally accepted. The mechanism of production is the same regardless of the exciting factor. In bronchial asthma the sequence of events is probably as follows:

A pressure gradient is created in the pulmonary alveoli due to the increased alveolar pressure and the decrease in caliber of the pulmonary vessels resulting from the prolonged expiratory phase of the lungs. As a result of this gradient, a so-called "marginal type" of alveolus ruptures and air escapes into the interstitial pulmonary tissue. (A "marginal type" of pulmonary alveolus is one in which the base of the alveolus borders on another structure such as a bronchus, bronchiole, blood vessel, connective tissue, or pleura, in contrast to the "partitional type," whose bases lie between alveoli.) Upon reaching the interstitial pulmonary tissue, the air spreads along the vascular sheaths to the mediastinum, where it results in mediastinal emphysema. After reaching the mediastinum the air may enter the soft tissues of the neck and chest wall, or may



Fig 1 Postero anterior chest film made six hours after the onset of subcutaneous emphysema in the neck. The air in the mediastinum is clearly visible along the left heart border, extending from the diaphragm to the root of the neck. The subcutaneous emphysema in the neck was easily seen on the original film.

pass downward along the aorta and esophagus to reach the retroperitoneal space. Pneumothorax or pneumoperitoneum may complicate mediastinal emphysema.

CASE REPORT

R. L., a white female, age 19, had been having acute paroxysms of bronchial asthma for several years. Early one morning, during an attack, she suddenly felt something "snap" in her upper chest, following which her neck began to swell. When seen at the Clinic about six hours later, she presented a moderate degree of subcutaneous emphysema of the neck and anterior chest wall. Auscultation of the chest revealed a peculiar sound in the region of the cardiac apex described by the clinician as

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"crunching" in character (Hamman's sign) In addition to dyspnea, the patient also complained of difficulty in swallowing solid foods A chest film (Fig 1) clearly showed the mediastinal collection of air, and the subcutaneous emphysema of the neck and superior chest wall No film studies of the esophagus or abdomen were made The patient was treated for her asthma and when she was seen two weeks later all signs and symptoms of the mediastinal emphysema had disappeared

Certain features concerning this complication of bronchial asthma are worth enumerating

1 The subcutaneous emphysema, usually in the base of the neck, is the symptom which first calls attention to the entity and results in further clinical and x-ray studies

2 All the reported cases, including our own, terminated in recovery under conservative treatment This probably indicates that the initial alveolar tear is small and closes over spontaneously and rapidly As yet there has been no need for surgical treatment

3 In many cases the appearance of subcutaneous emphysema results in sudden rapid improvement of clinical symptoms of asthma (dyspnea and cyanosis) because it acts as a release mechanism for pulmonary interstitial emphysema (This was not true in our case) Prior to the release of the air into the mediastinum and thence into the subcutaneous tissues, it produces pressure on the blood vessels of the lungs, mediastinum, and heart (malignant interstitial emphysema of Macklin)

The diagnosis can be made both clinically and by x-ray examination Presence of

air in the subcutaneous tissues of the neck, plus the peculiar crunching or crackling sound heard on auscultation over the mediastinum is pathognomonic clinically The x-ray findings include air in the subcutaneous tissue of the neck and chest, and demonstration of air in the mediastinum The latter finding may be seen either on the postero-anterior or lateral view In the lateral view the air is seen in the space between the heart and sternum On the postero-anterior view the air is seen between the heart shadow and the mediastinal pleura (Fig 1) With appropriate x-ray studies air in the retroperitoneal space could be demonstrated if present The appearance would be similar to that recently reported (4) for retroperitoneal perforations of the duodenum In these latter cases the air may extend superiorly into the mediastinum and neck

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SUMARIO

Enfisema Mediastínico Durante un Acceso Agudo de Asma Bronquial

Comunicase un caso de enfisema del mediastino que ocurrió durante un acceso agudo de asma bronquial Cabe explicar el fenómeno a base de una pendiente de mayor presión en los alvéolos pulmonares, con rotura de un alvéolo de "forma marginal" y difusión del aire escapado a lo largo de las vainas vasculares al mediastino El paso del aire a los tejidos blandos del cuello y de

la pared torácica produce un enfisema subcutáneo asociado, que suele ser el primer signo del estado El diagnóstico se hace tanto clínica cuanto roentgenográficamente En las radiografías laterales se observa el aire en el espacio entre el corazón y el esternón En las posteroanteriores aparece entre la sombra cardíaca y la pleura mediastínica

Studies of the Effect of Roentgen Rays on Healing of Wounds

III Histological Changes in Skin Wounds in Rats Following Postoperative Irradiation with Very Small and Moderate Doses¹

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THE EFFECT OF roentgen rays on the healing of skin incisions in rats has been the subject of previous experimental studies by Pohle and Ritchie (6, 7, 8). In spite of the importance of the clinical aspects, the subsequent literature contains only scanty, conflicting evidence concerning the effect of irradiation upon the healing of surgical wounds. This is particularly true with regard to the use of small doses of roentgen rays, a better understanding of this question should lead to a more satisfactory combined surgical and radiation procedure in the therapy of malignant disease.

While Pohle, Ritchie, and Wright (6) demonstrated that wound healing in rats is retarded by irradiation of the skin with 1,000 r, especially when given twenty-four hours after the incision, there is not complete agreement in the literature as to the effect when smaller doses are used. Fukase (4) found that following doses of about 400 r in rabbits the wounds contained less exudate than in the controls. Businco and Cardia (2) believed that 150 r had a stimulating effect on the healing process in dogs, although only four animals were used in their experiments. Nathanson (5), using gamma radiation, found that small doses accelerated the healing of incisions made in the abdominal skin in dogs.

Dobbs (3) conducted a series of experiments on rats, in which various amounts of radiation were given to skin wounds. On each of his animals he made two 4 cm wounds, one of which he exposed to roentgen rays while the other served as a con-

trol. The tensile strength of the scars was tested after varying intervals, and in some cases histologic sections were obtained. The results showed that doses of 300 r given immediately after the wound was inflicted caused an increase in the tensile strength of the scar. Doses of about 1,000 r caused a decrease if given prior to the incision and no change if given afterward.

The present investigation has been undertaken in order to study the effect of roentgen rays applied in doses of 10, 25, 150, 300, 350, and 700 r upon the healing of wounds in rats. The technical factors were 100 kv, 5 ma, 2 mm Al, 30 cm focal skin distance, 2 × 2 cm field, 45 r/min (half-value layer in Al, 3.5 mm).

METHOD AND EXPERIMENTS

The method employed was substantially the same as described in our earlier publications. Albino rats of the Sprague-Dawley strain, approximately 200 gm in weight, were used. Under ether anesthesia a midline incision 4 cm long was made on the back and a Michel clip applied at the midpoint of the wound. No further closure was attempted. The experimental work was divided into three groups as described below.

Group 1 Eighteen rats were used. In each of these one-half of the wound was irradiated immediately after the incision was made, and the other half was used as a control. These wounds were observed grossly for fourteen days, during which

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TABLE I OBSERVATIONS ON ANIMALS WHOSE WOUNDS WERE IRRADIATED IMMEDIATELY

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	1	1	0	2	0	4
Healing retarded	0	0	3	7	5	15
No effect	5	7	12	5	10	39
Animals discarded	2	0	0	1	0	3

period a special effort was made to detect any difference between the two halves in regard to rapidity of healing

The animals were divided as to dosage as follows Rats 1-6, 150 r, rats 7-12, 350 r, rats 13-18, 700 r

Group 2 Ninety rats were used. These were divided into 3 groups of 30 each, according to the dosage used. The first group received 150 r, applied to one-half of the wound, the second group 300 r, and the third group 700 r. In each group 15 animals were treated immediately and 15 were treated twenty-four hours after the incision. Each group of 15 animals was finally divided into three groups of 5 each, these groups were sacrificed when the wounds were three, five, and seven days old, respectively. In approximately one-half of the animals, the cephalic portion of the wound was treated, in the rest, the caudal part was irradiated.

Group 3 A total of 32 rats was used. In 16 the lower half of the wound was exposed to 25 r, in the remaining 16 animals to 10 r. Irradiation was given either immediately or twenty-four hours after the incision had been made. The animals were sacrificed three and five days, respectively, after the incision.

In all animals the tissue about the wound was fixed in Bouin's solution. Blocks were cut from the treated and untreated part of each wound and embedded in paraffin, and sections were stained with hematoxylin and eosin.

RESULTS

Group 1 Although all wounds were examined daily, no consistent difference between irradiated and non-irradiated portions of the wound could be detected (Figs

TABLE II OBSERVATION ON ANIMALS IN WHICH THE WOUND WAS IRRADIATED AFTER TWENTY-FOUR HOURS

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	1	2	2	1	0	6
Healing retarded	0	1	3	5	5	14
No effect	6	5	9	8	8	36
Animals discarded	1	0	1	1	2	5

TABLE III SUMMARY OF TABLES I AND II

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	2	3	2	3	0	10
Healing retarded	0	1	6	12	10	29
No effect	11	12	21	13	18	75
Animals discarded	3	0	1	2	2	8

1A and B). Any differences which were found could easily be explained by differences in approximation of the wound margins or by infection. Almost all wounds were healed in twelve days, with scattered unhealed portions. The distribution of these foci of retarded healing was such as to exclude any relation between the irradiation and the speed of healing.

Group 2 In evaluating the results by histologic examination, the most important criterion was considered to be the amount of visible fibroblastic reaction in the margins of the wounds. The actual degree of closure could not always be taken as being commensurate with this reaction, since approximation of the margins was not uniform with the method used.

A summary of the results is presented in Tables I, II, and III, in which the animals are divided according to dosage, and each group is analyzed as to progress in healing of the irradiated portion of the wound as compared to the untreated part. It will be noted that the total number of animals evaluated is only 114, since 8 had to be discarded because of infection of the wounds or distortion which made evaluation impossible (Table III).

One fact was evident, however, which is not indicated in the tables. The degree of difference in healing between the two parts of the wounds is of some importance. It was found that the difference in favor of

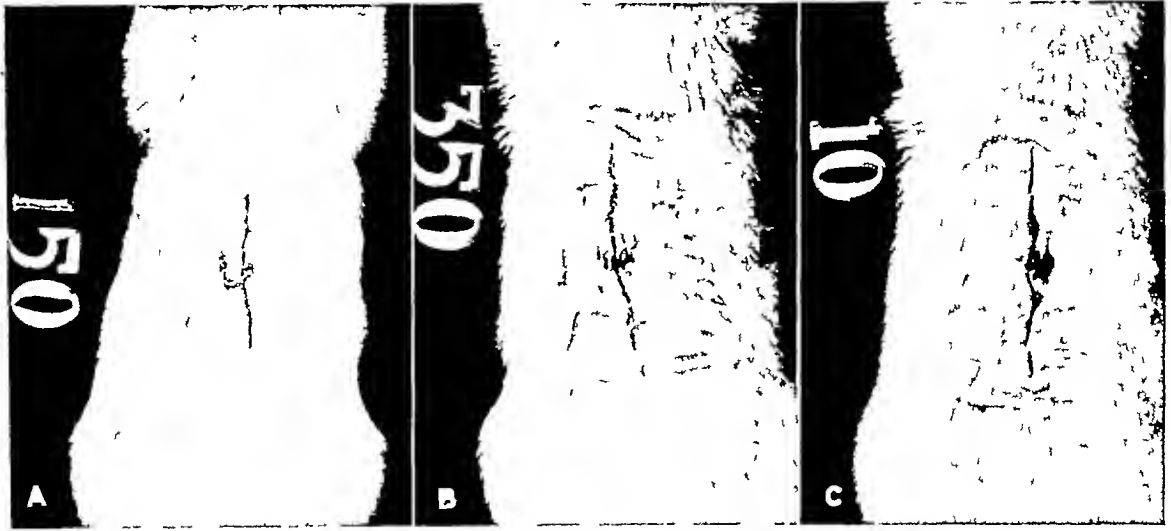


Fig 1. Cranial half of wound irradiated immediately after the incision had been made. A. Exposure of 150 r B 350 r C 10 r Macroscopically there is no difference in the appearance of the irradiated and non irradiated portions of the wounds five days later

the irradiated portion of the wound was never very pronounced, whereas that in favor of the control portion was in many cases considerable, especially with the higher doses

Any retardation of healing in the irradiated portions was temporary, the number of rats in which such slowing was evident was at a maximum three days after incision, and by the seventh or eighth day was greatly reduced. This agrees with our former observations.

In many specimens the epithelium had bridged the defect completely, in spite of a minimum of fibroblastic activity in the underlying tissue, and in this respect no difference was observed between the irradiated and control specimens.

Group 3 As can be seen from the statistical tables, the irradiated wounds in some of the rats receiving 25 r and in those receiving 10 r tended to be slightly advanced in their healing as compared with the control portion of the wounds. While this was demonstrated histologically, we did not observe it macroscopically in our daily studies of the incisions (Fig 1C). This advantage seemed in a few cases to be the result of greater fibroblastic growth, but in a larger number it appeared to be due to a smaller amount of acute inflammatory

exudate than in the control section, with less fibrin to be replaced by scar tissue. In these instances the actual degree of fibroblastic activity appeared to be the same in the irradiated as in the control sections (Figs 2-5).

DISCUSSION

The object of this study was to submit to histologic scrutiny the claim brought forth by various authors, namely, that small doses of x-rays stimulate or accelerate the healing of incisions on the skin. We have not been able to find any histologic evidence that such doses actually stimulate the healing process. The time interval between incision and irradiation, in our experiments either a few minutes or twenty-four hours, seemed to be of no significance.

Nathanson (5), on the other hand, using dogs, observed acceleration of healing only in those animals which were irradiated with small doses immediately after the incision had been made, while those irradiated twenty-four hours later did not show that effect. He leaves the question open whether this phenomenon is due to a depression of the inflammatory process, a stimulation of the connective-tissue cells, or to both.

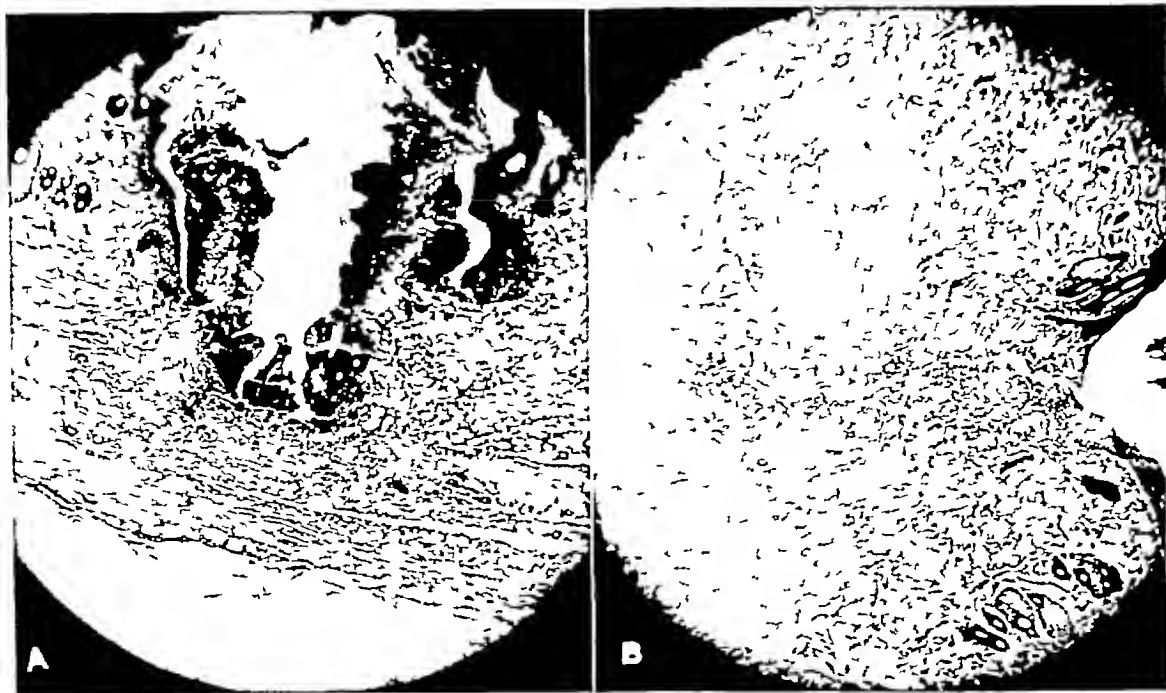


Fig 2 Rat 8A, 25 r given immediately after incision Wound is five days old A Control half of wound B Irradiated half, showing a more vigorous fibroblastic reaction and better union

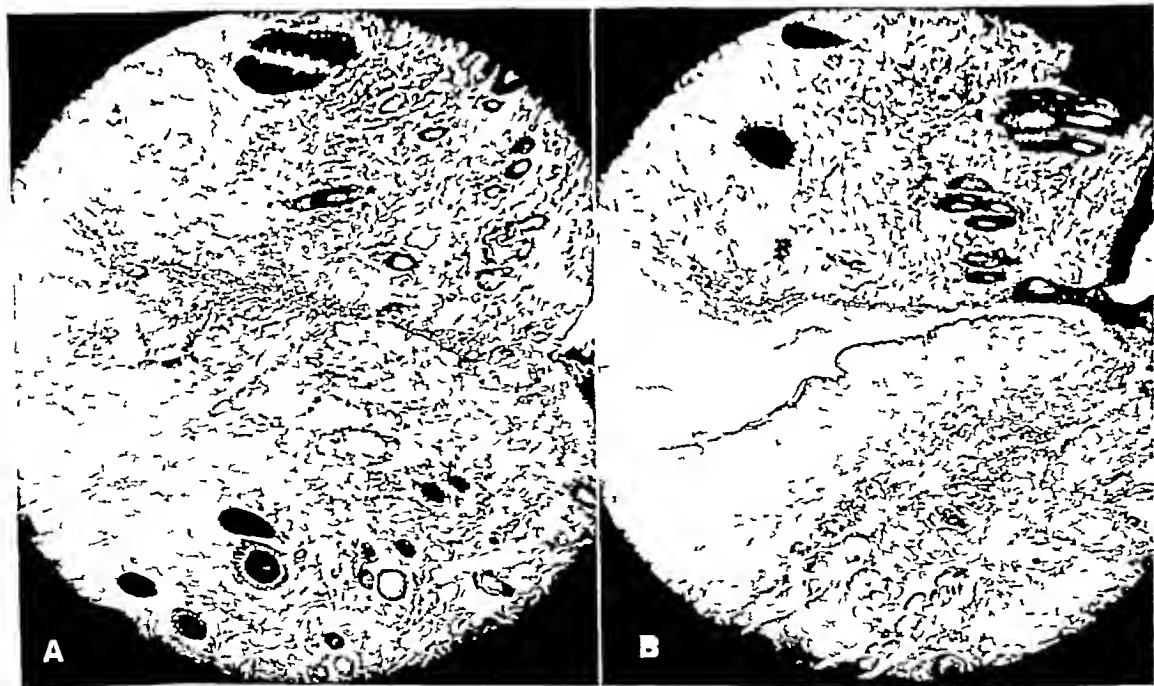


Fig 3 Rat 10A 25 r given twenty-four hours after incision Wound is three days old A Control half of wound B Irradiated half Almost no healing in A with abundant inflammatory exudate Only slightly greater fibroblastic reaction in B but almost no exudate and more advanced healing

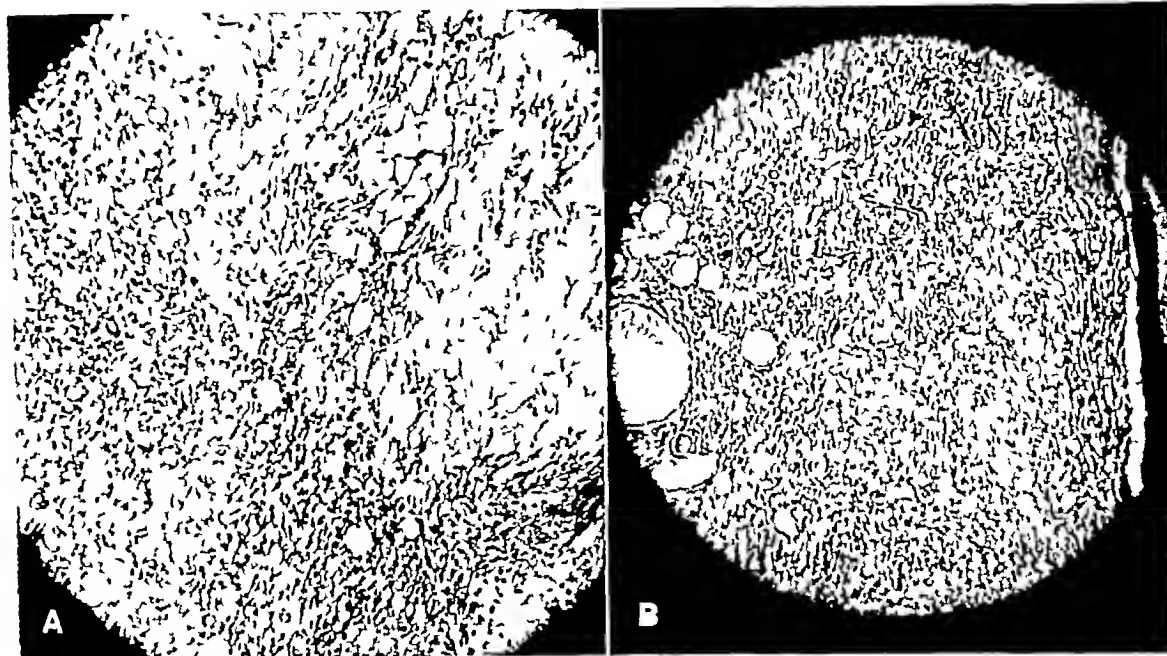


Fig 4 Rat 6B, 10 r given immediately after incision Wound is five days old A Control half of wound B Irradiated half, showing considerably narrower scar Vigorous fibroblastic reaction in both

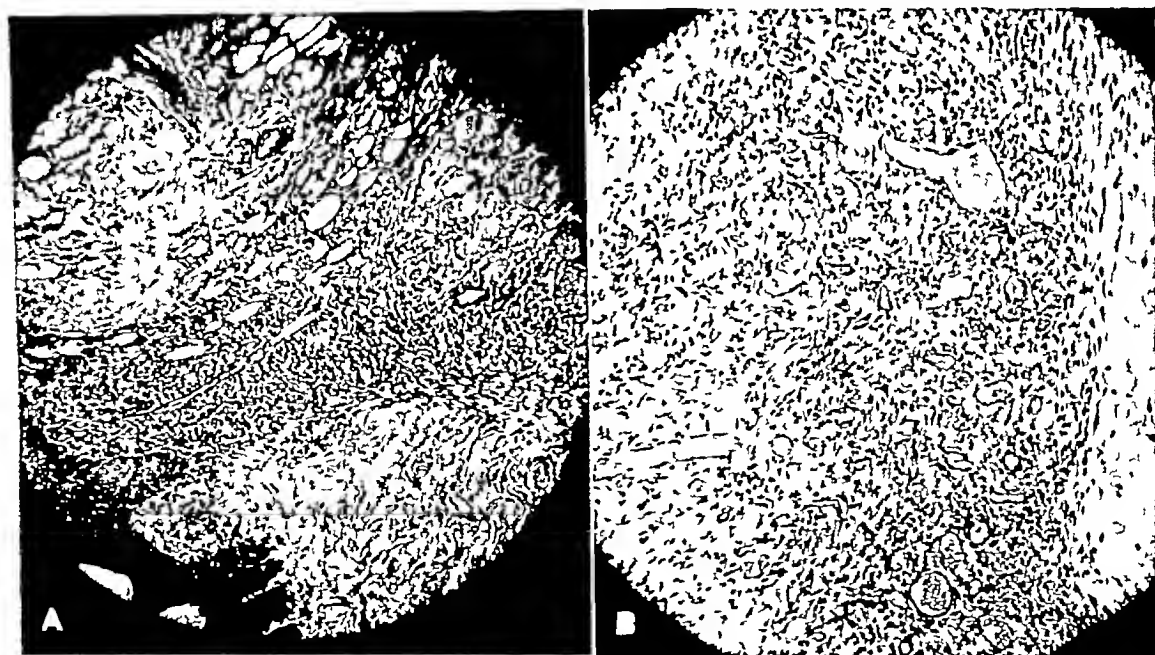


Fig 5 Rat 14B, 10 r given twenty four hours after incision Wound is five days old A Control half of wound B Irradiated half Scar in B is much less abundant

The histologic study of the sections involved in the present study has brought to light some facts which may explain the conflicting opinions which exist with regard to the effect of low doses on the healing

process It was noted, for example, that the progress toward healing, particularly when the lower doses were used, depended greatly on the approximation of the margins of the wound Specifically, in one

rat (150 r applied twenty-four hours after incision), both halves of the wound were well healed. Approximation, however, was slightly better in the irradiated half, and here the scar was much less conspicuous. The difference in healing sometimes seemed out of proportion to the difference in approximation. Such a situation suggested the possibility that the lower doses, while not affecting the actual production of fibroblasts, might cause a significant reduction in the amount of exudate in the wound. There would accordingly be less fibrin to be replaced by scar tissue and hence a smaller, less conspicuous scar. Such a change would take place, not by reason of actual stimulation of healing, but rather by a reduction in the amount of exudate which the healing process must replace. This hypothesis is in agreement with the work of Fukase (4) and of Buhtz (1). These authors, although differing somewhat as to details, agreed that small doses of roentgen rays administered immediately after the incision caused a decrease in the amount of exudate in the wound as early as five hours after the exposure.

Another problem to be solved is the actual functional effect of x-rays upon the fibroblasts. In doses which cause obvious growth changes in these cells the irradiation may be followed by the appearance of bizarre giant fibroblasts, abnormal cells which very probably are altered in their ability to produce collagen. Used in lower doses, which cause no histologic change detectable by ordinary means, x-rays may possibly create changes in the production of pre-collagenous and collagenous substance which affect materially the tensile strength of the wound. Further studies, both tinctorial and chemical, should be done in order to answer this question.

SUMMARY

1 The effect of roentgen rays in doses of 10, 25, 150, 300, 350, and 700 r (half-value layer in Al, 3.5 mm) on the healing of skin incisions was studied macroscopically only in 18 and macroscopically and microscopically in 122 white rats.

2 Although all wounds were examined daily, no consistent difference in the healing time between irradiated and non-irradiated portions of the wound could be detected macroscopically.

3 Histologically, no true stimulative effect on the healing—even with the lowest doses used—could be found.

4 Any slight difference in the healing process in favor of the irradiated portion (small doses only) was considered to be due to a reduction in the amount of exudate, which in turn decreases the amount of fibrin to be replaced by scar tissue.

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SUMARIO

Estudios del Efecto de los Rayos X sobre la Cicatrización de las Heridas
III Alteraciones Histológicas en las Heridas Cutáneas en las Ratas
después de la Irradiación Postoperatoria con Dosis Muy Pequeñas
y Moderadas

El efecto de los rayos X a dosis de 10, 25, 150, 300, 350 y 700 r (capa de hemireducción en aluminio = 3.5 mm) sobre la cicatrización de las incisiones cutáneas fué estudiado macro y microscópicamente en 122 ratas blancas

Aunque todas las heridas fueron examinadas a diario, no pudo distinguirse macroscópicamente ninguna diferencia constante en el tiempo de cicatrización entre las puertas irradiadas y las no irradiadas

Histológicamente, no pudo descubrirse ningún verdadero efecto estimulante sobre la cicatrización—ni aun con las mínimas dosis utilizadas

Toda leve diferencia en el proceso cicatrizante en pro de la porción irradiada (solamente con pequeñas dosis) fué considerada como debida a disminución en la cantidad de exudado, lo que a su vez hace bajar la cantidad de fibrina que debe ser reemplazada por tejido cicatricial



Effects of Continuous Radiation on Chick Embryos and Developing Chicks¹

I Growth Rate, Gonads, and Bone

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THERE IS INCREASING demand for exact knowledge regarding the biological effects of continuous prolonged irradiation. The use of radioactive isotopes in medical therapy and exposure to radioactive substances in industry and scientific work (probably one of the greatest hazards today) presuppose such a knowledge, which actually is fragmentary and ill-defined. The following experiments were planned for the purpose of plotting out the effects, on different tissues, of large and small doses of radiation in relation to time intervals of exposure, and to establish the lethal threshold for cells of various types at different stages of development. Since very little work has been done with avian tissues, particularly in relation to the nucleated red blood cells, chicks were utilized.

MATERIALS AND METHODS

The agent chosen was the radioactive isotope P^{32} , and the subjects, chick embryos and growing chicks. The source of radiation, the isotope P^{32} (combined as KH_2PO_4 in an aqueous solution containing from 1,000 to 2,000 $\mu\text{c}/\text{c c}$ of solution), has a half-life of fourteen days which insures sustained radiation.² P^{32} emits relatively soft beta rays, half of them being absorbed by 3 mm of tissue and all of them by 8 mm of tissue. The chick embryo was an ideal subject for insuring continuous irradiation with measured amounts of radioactive material, since this could be administered easily by intra-yolk injections and there was no loss through excretion during incubation. All of our

eggs were taken from the same flock of White Leghorns over a three-month period. Incubation was carried out under the usual conditions, 38 to 39° C, 70 to 80 per cent relative humidity. The incubation period varied from twenty to twenty-one days.

To obtain an accurate and continuous picture of the radiation effects on the developing chick we used several groups of incubated eggs and chicks at various stages of development, each group was given a different dose of P^{32} . The amount of radiation administered and the ages of the subject at injection and when killed are given in Table I. Our experiments may be divided into three groups. In the first group are the embryos given a single injection. A sterile solution of P^{32} , as KH_2PO_4 , was injected into the yolk from the fourth to the fourteenth day of incubation in amounts varying from 47.5 to 300 μc . In the second group are the chicks from one to thirty-seven days old given a single subcutaneous injection with approximately isotonic solutions of P^{32} , as KH_2PO_4 , in amounts from 115 to 1,050 μc . The third group consists of those chicks receiving multiple injections, the limits of total dosage being 180 μc and 3,696 μc . Chicks were killed by decapitation at intervals designed to give a continuous picture of the radiation effects. The lethal dosage for embryos and chicks varied with the age. Hatching percentages for injected eggs were as follows: 120 μc on fourth day of incubation, 15 per cent, 100 μc on eighth day, 30 per cent, 100 μc on fourteenth day, 50 per cent.

¹ This work was done under Government Contract N5-ori-76 in the Laboratory of Pathology of the Harvard Cancer Commission. Accepted for publication in May 1948.

² P^{32} used in this work was supplied by Oak Ridge National Laboratories, Oak Ridge, Tenn.

TABLE I EMBRYOS AND CHICKS INJECTED WITH P³³
(Amount of P³³ Injected, Age of Embryo or Chick at Time of Injection, and Age When Killed)

Embryos Injected (50)									
Amount of P ³³ →	47 5 μ c	120 μ c	100 μ c	100 μ c	180 μ c	200 μ c	200 μ c	300 μ c	
Age at Time of Injection →	5th Day of Incubation	4th Day of Incubation	8th Day of Incubation	14th Day of Incubation	4th Day of Incubation	8th Day of Incubation	14th Day of Incubation	14th Day of Incubation	
Ages of birds and embryos taken for histologic study	(2) * 1 day chick 2-day chick 4-day chick	9-day embryo 13 day embryo 15-day embryo 18-day embryo Hatching chick 2-day chick 22-day chick 51-day chick	(2) * 1-day chick 3-day chick 54-day chick 55-day chick 58-day chick	16-day embryo 18-day embryo 19-day embryo (2) * 20-day embryo Hatching chick 3-day chick 7-day chick 11-day chick 15 day chick	13-day embryo 15-day embryo 18-day embryo Hatching chick	(3) * 1 day chick (2) * 15-day chick	17-day embryo 18-day embryo 1-day chick 3-day chick 5-day chick 7-day chick 9-day chick 11-day chick 13 day chick 15-day chick	17-day embryo (2) * 7-day chick	4-day chick
Chicks Receiving Single Injection (18)									
Amount of P ³³ →	170 μ c	180 μ c	235 μ c	300 μ c	760 μ c	1,050 μ c	1,050 μ c previously incubated	500 μ c	700 μ c
Age at Time of Injection →	1-day chick	4-day chick	6 day chick	20-day chick	29-day chick	37-day chick	37-day chick	24-day chick	22-day chick
Ages of birds taken for histologic study	2 day chick	6-day chick	20 day chick (2) * 57-day chick	43 day chick 51 day chick	52-day chick 55 day chick 60-day chick	57-day chick 60-day chick 60-day chick	55-day chick 59-day chick	35-day chick	(2) * 30-day chick
Chicks Receiving Multiple Injections (6)									
Amount of P ³³ and Time of Injection	100 μ c, 20 day chick 80 μ c, 22-day chick 100 μ c, 24-day chick	100 μ c, 20 day chick 80 μ c, 22-day chick 100 μ c, 24-day chick	100 μ c, 20 day chick 80 μ c, 22-day chick 100 μ c, 24-day chick	700 μ c, 24-day chick 400 μ c, 27-day chick	700 μ c, 24-day chick 400 μ c, 27-day chick	518 μ c, 21-day chick 600 μ c, 25-day chick	420 μ c, 26 day chick 300 μ c 32-day chick 1,000 μ c, 45-day chick 670 μ c, 54-day chick 280 μ c, 65-day chick	600 μ c, 31 day chick 670 μ c, 40 day chick 390 μ c, 51-day chick 1,036 μ c, 66-day chick 1,000 μ c, 70-day chick	
P ³³ Total	180 μ c	280 μ c	280 μ c	1,100 μ c	1,100 μ c	1,118 μ c	2 670 μ c	3,696 μ c	
Age of birds taken for histologic study	30 day chick	30-day chick	30-day chick	34-day chick	34-day chick	38-day chick†	75 day chick	-79 day chick†	

* Numbers in parentheses to left of age of chicks indicate more than one chick killed on that day
† Indicates chicks that died as a result of radiation

TABLE II TISSUE ACTIVITY

No of Chick	Amount of P^{32} Injected	Age at Injection	Time Between Injection and P^{32} Tissue Activity Determination	Bone	Liver	Muscle
376	120 μ c	4th day incubation	40 days	1 79	0 15	0 159
590	200 μ c	8th day incubation	29 days	18 36	0 88	0 84
592	200 μ c	8th day incubation	29 days	15 00	0 77	0 71
617	235 μ c	6 days after hatching	14 days	13 2	0 64	0 52
611	235 μ c	6 days after hatching	51 days	0 021	0 0017	0 0017
612	235 μ c	6 days after hatching	51 days	0 0208	0 0023	0 0025
544	300 μ c	19 days after hatching	24 days	0 2	0 02	0 015
604	760 μ c	29 days after hatching	24 days	0 31	0 026	0 026
608	760 μ c	29 days after hatching	26 days	0 16	0 014	0 014

This embryo mortality was, however, not entirely due to radiation. Injection of non-radioactive KH_2PO_4 in amounts equal to the radioactive doses used accounted for about half the mortality. Hatchability of non-irradiated eggs was 75 per cent.

Blood counts were made according to the method described by Carl Olson, Jr (1). In this method the red blood cells and granulocytes are counted directly in a counting chamber with the use of phloxine as a differential stain. A differential white count is made on a smear, and the lymphocyte count is calculated. This method is reasonably accurate in all instances except in the calculation of the lymphocyte count when the granulocyte count is near zero and the differential count is nearly 100 per cent lymphocytes. Since these lymphocyte values are subject to error, they are omitted.

The most important and direct radiation effects were on bone marrow, peripheral blood, the lymphoid system, bone, cartilage, and gonads. The radiation effects and associated changes of these organs will be discussed more fully below.

So far as we know, only two papers have dealt with the effects of P^{32} irradiation on tissues. A brief report of four autopsies of patients who received P^{32} in the treatment of leukemia is given by Lawrence, Scott, and Tuttle (3). Platt (4) examined the tissues from a sizeable series of autopsies of patients treated with P^{32} . He described changes in skin, esophagus,

gastro-intestinal tract, liver, kidneys, ureters, bladder, pancreas, heart, lungs, and skeletal muscles, attributed to radiation, which were not seen in our chicks. There is a discrepancy between his observations and ours which cannot be explained altogether by the difference in experimental conditions. The range of dosage of radioactivity per unit weight used by us was about six times higher than the therapeutic dosage in Platt's series, but the intervals after irradiation at which our observations were made were much shorter.

OBSERVATIONS

1 *Location of P^{32}* The first set of observations was made on the location and movement of P^{32} after injections into the incubated eggs (2). It is sufficient here to note that 90 per cent of the P^{32} injected into the yolk of an egg on the fifth day of incubation was taken up by the developing embryo and that at hatching this was shown by autoradiograms (Fig 2) to be concentrated principally in the bones.

The amounts of P^{32} retained by the various tissues in chicks injected both during incubation and after hatching were traced by radioactive measurements (Table II) and by autoradiograms.³ Excretory loss was not measured. As in the embryo,

³ The authors wish to express their appreciation to Mrs Kathryn Haley and Mr Russell Cowing of the New England Deaconess Hospital for invaluable technical assistance in making autoradiograms and in measurement of radioactivity in chick tissue.



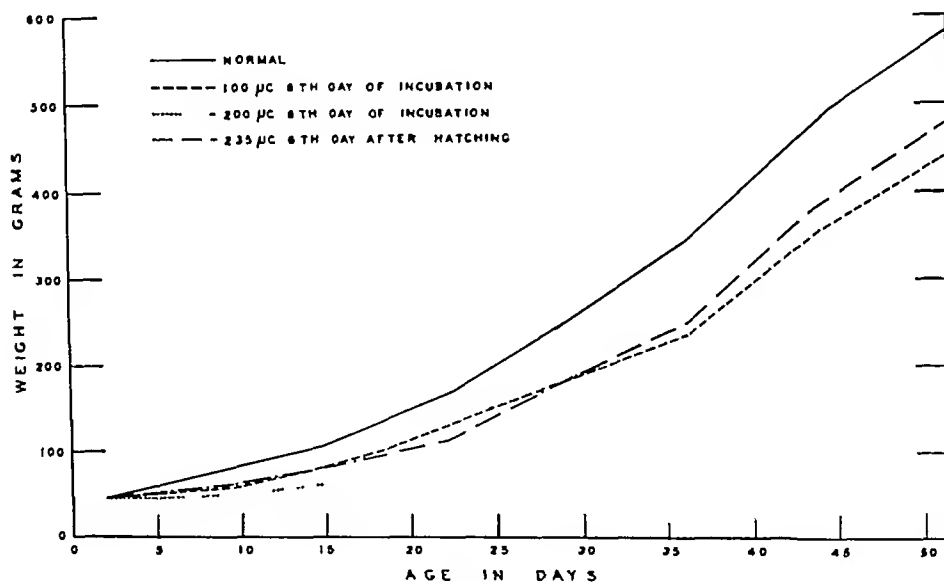
Fig 1 Comparison of irradiated and non-irradiated twenty-three-day male chicks. The administration of $120 \mu\text{C}$ P^{32} to the smaller chick on the fourth day of incubation caused dwarfing and inhibited secondary sex characteristics, as evidenced by hypoplasia of the comb

the ability of the bones to pick up the injected phosphate

Since the beta radiations of P^{32} penetrate only 8 mm of tissue, a large part of the ionizing effect was spent in or near the bones. The other tissues of the body, therefore, received relatively slight but fairly uniform irradiation only in the first few days after injection

2 *Effect of Radiation on Growth* Radiation retarded growth of male and female birds alike. This inhibition did not affect one part more than another. There was no gross deformity of structure, but the suppression of growth resulted in a miniature of the normal bird⁴. This is illus-

GROWTH OF NORMAL AND IRRADIATED CHICKS



Graph 1

P^{32} was progressively concentrated in the bones. Forty-eight hours after subcutaneous injection there was only slightly greater deposition in bones than in other tissues, but two weeks later the concentration in bone was twenty times greater than that in the soft tissues. In general, this concentration of retained P^{32} in the bones of our chicks was higher than that which has been reported in rodents and man (4-6). Part of this difference may have been due to the rapid growth of our immature chicks, which would increase

trated in Figure 1, where a male chick injected with $120 \mu\text{C}$ on the fourth day of incubation is compared twenty-three days after hatching with a normal male chick of the same age. The effectiveness of radiation in retarding growth depended on the age of the subject. While $200 \mu\text{C}$ was much more effective than $100 \mu\text{C}$ when given on the eighth day of incubation,

⁴ Certain secondary sex changes to be discussed later are contrary to this generalization. These changes are probably not due primarily to radiation effects but secondarily to changes in the gonads caused by radiation.



Fig 2 Autoradiogram of chick femur at hatching The chick had been given $100 \mu\text{C}$ P^{32} on the fourteenth day of incubation Section is unstained The black zone in region of calcified bone shows presence of radioactivity Muscle and cartilage show little or no radioactivity $\times 33$

$235 \mu\text{C}$ given six days after hatching had little more effect than $100 \mu\text{C}$ on the eighth day of incubation Growth curves for treated chicks are compared with normal curves on Graph I

3 Effect of Radiation on Gonads In the chick, as well as in the chick embryo, the gonads of both sexes occupy approximately the same anatomical position and are roughly equal in size Thus the comparative sensitivity of ovary and testis to radiation from P^{32} could be easily determined We were able to compare the development of the gonads under normal and experimental conditions up to two months after hatching

Because the effect of irradiation on the gonads, and more specifically on the germ cells, varied according to the stage of development, it may be helpful to review briefly the development of the chick gonads They appear on the medial surface of the mesonephros In the undifferentiated stage they are made up of closely packed germ cells and undifferentiated epithelial cells (both of which are undergoing mitosis) and are covered by a layer of cuboidal to columnar cells Distinguishing characteristics appear on the seventh day In the gonad destined to become a testis, epithelial tubules containing primitive germ cells develop in the

medulla, while the cortex begins to atrophy During the second week of embryonic life, the tubules are well formed, the ratio of spermatogenic to epithelial cells being about 1 to 5 or 10 Interstitial cells are first recognized on the ninth day The ovary is recognized on the seventh day by closely packed primitive ova undergoing mitosis and expanding the cortex Stromal proliferation gradually isolates each ovum In the five-day-old chick, isolated ova are scattered singly in newly developed stroma, and most of them are surrounded by follicular cells identical to and in some instances continuous with the surface epithelium From then on, the ova grow by intracellular accumulations, at two months of age, the largest are 500μ in diameter This description applies only to the left ovary, the right having atrophied during the latter half of incubation

Testis The primary effect of radiation is destruction of the germ cells with little or no immediate change visible in the other elements Only after a period of several weeks of irradiation were the irradiated testes noticeably smaller than normal At this time they showed retarded tubular development Because these somatic testicular changes were of almost equal degree regardless of amount of radiation, and persisted after significant

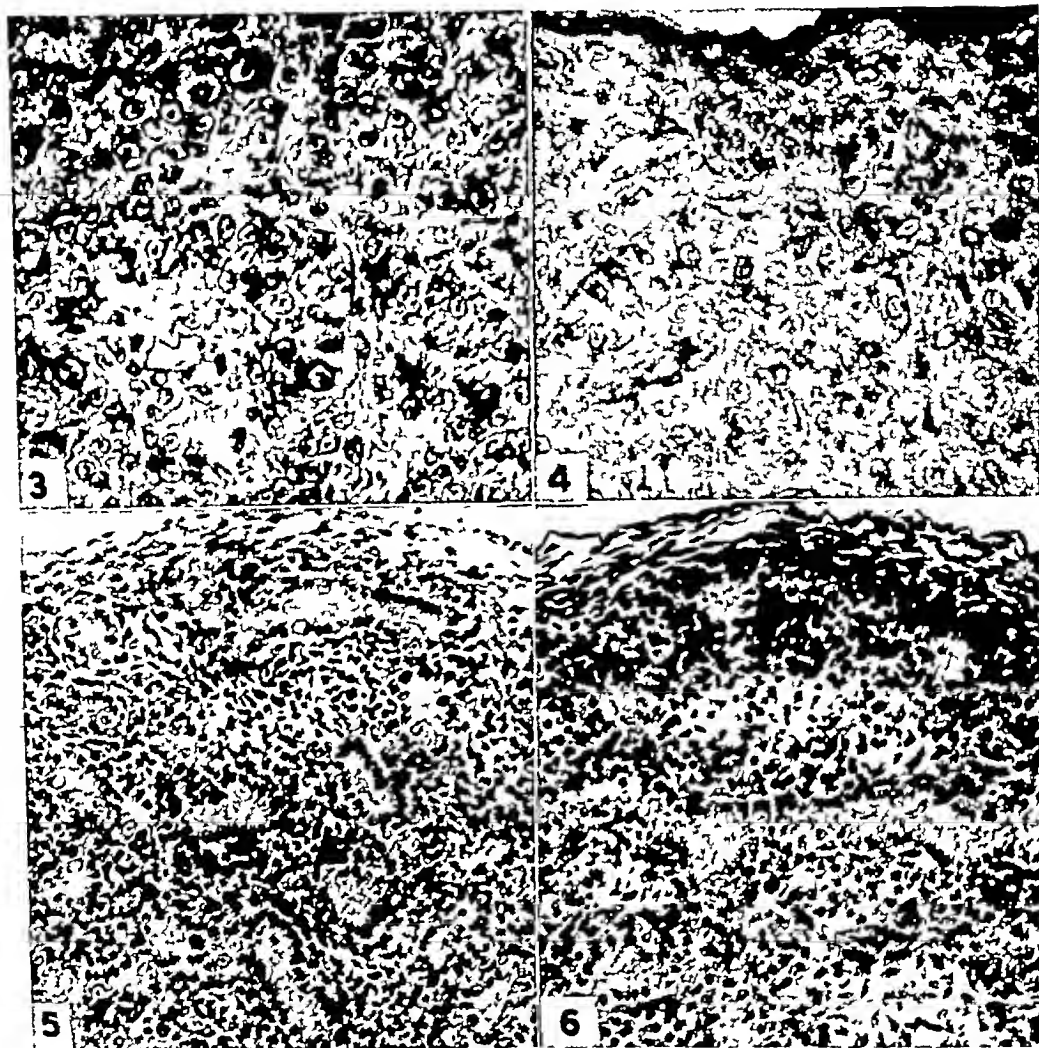


Fig 3 Testis of normal eight day embryo Note tubule formation and numerous large germ cell nuclei

Fig 4 Testis of nine-day embryo injected with 120 μ c on fourth day of incubation Note absence of large germ cells and reduced number of tubules as compared with normal in Figure 3 The interstitial elements also appear more condensed than normal Figs 3 and 4 $\times 600$

Fig 5 Testis of normal hatching chick Tubules are lined by regular columnar epithelium and contain many germ cells with large pale nuclei Note germ cell in mitosis near lower left corner

Fig 6 Testis of hatching chick which received 100 μ c on eighth day of incubation The only apparent abnormality is complete lack of germ cells in the tubules Compare with normal as seen in Figure 5 Figs 5 and 6 $\times 300$

amounts of radiation remained, it seemed possible they were secondary to loss of germ cells rather than the direct result of radiation injury

The amounts of P^{32} injected into embryos varied from 47.5 μ c on the fifth day of incubation to 300 μ c on the fourteenth day. Despite these wide variations, the testes of chicks at hatching all showed essentially the same changes (Fig 6), germ cells were entirely destroyed while

other elements were unharmed. This implies a high degree of sensitivity of the germinal epithelium. Only the embryos injected very early in incubation, the fourth day, showed, in addition to loss of germ cells, a slight decrease in tubule formation during incubation (Fig 4).

With lapse of time, testes of irradiated embryos showed more marked gross abnormality. In birds which were moribund fourteen, sixteen, and eighteen days after

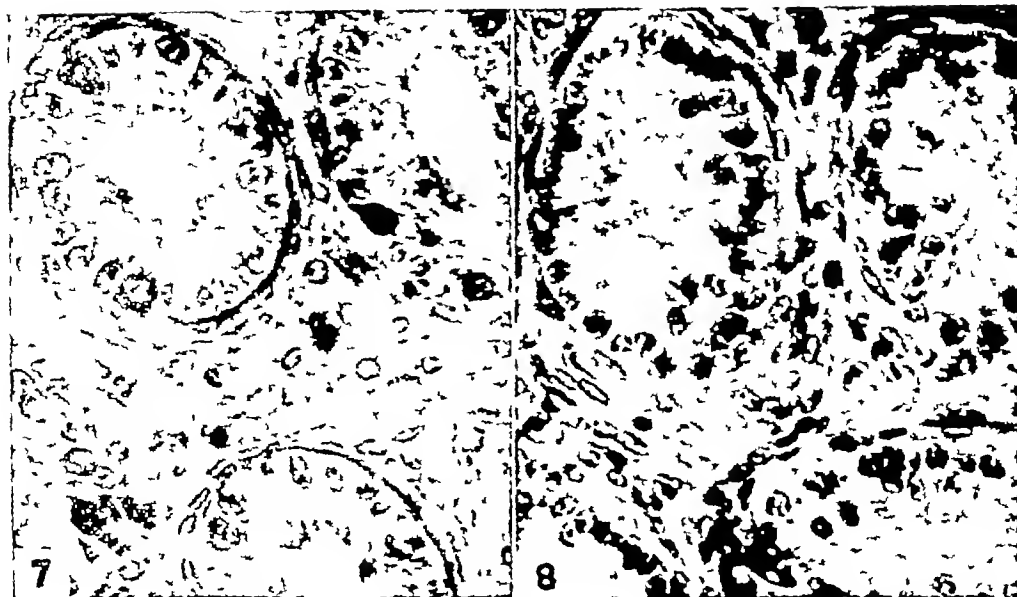


Fig 7 Testicular tubules from normal seven-week chick. Tubules are lined by columnar epithelium and contain germ cells with large nuclei and dark cytoplasm. Interstitial tissue is composed of loosely arranged connective-tissue cells. $\times 600$

Fig 8 Testicular tubules from fifty-four-day chick given $100 \mu\text{c}$ on eighth day of incubation. Germ cells are absent, tubules have small lumens, and lining cells are markedly vacuolated. Interstitial tissue is slightly more condensed than normal (Fig 7), and the nuclei are smaller. $\times 600$

injection of $200 \mu\text{c}$ on the fourteenth day of incubation, the only gross testicular abnormality was a slight diminution in size. The histologic changes consisted of loss of germinal epithelium and some tubular atrophy. The testes were one-half normal diameter thirty-nine days after injection of a four-day embryo with $120 \mu\text{c}$. The tubules were narrowed, and there was loss of spermatogenic cells, but the normal columnar epithelium and the basement membrane were unaltered. The interstitial cells were also normal in structure. The stroma appeared slightly condensed, suggesting atrophy. The most advanced changes were noted from six to seven weeks after administering $100 \mu\text{c}$ to eight-day embryos (Fig 8); the testes were one-third to one-half the normal diameter, the tubules were atrophic, the lumen small and void of spermatogenic cells, the columnar lining cells showed cytoplasmic vacuoles of doubtful significance, the basement membrane was less distinct than normal, the stroma appeared slightly condensed, but the interstitial cells were normal in structure and distribution.

In the chicks injected subcutaneously with P^{32} after hatching, the same destruction of spermatogenic cells with similar minor changes in other testicular elements was seen. Forty-eight hours after injection of $180 \mu\text{c}$, the testes of a four-day male chick had lost nearly all of the spermatogenic cells, only a few degenerating forms were still visible. The tubular epithelium and interstitial cells showed some hydropic change, and there was moderate interstitial edema, changes characteristic of acute radiation reaction. Observations from four to forty-eight days after injection revealed no edema or hydropic changes. The loss of spermatogenic cells was constant and was the only testicular change apparent during the first week after injection. Several weeks later, atrophy of the testicle became apparent and the changes were the same as those seen in the irradiated embryos examined a number of weeks after hatching.

In none of the male birds irradiated during incubation did secondary sex characteristics develop during the sixty-day observation period. At two weeks the

comb of a normal male chick distinguishes it from a female, and by four weeks the comb is very prominent. At eight weeks the normal male and female comb, wattles, and body structure are distinct and characteristic. These male birds irradiated during incubation had no large red combs or wattles, and their body structure was not definitely male. An early example of this change is seen in Figure 1.

Discussion The primitive spermatogenic cells of the testes of embryos and chicks of all ages were completely destroyed by all doses of radiation used in these procedures, but significant primary radiation changes in the other testicular elements were not found even after the largest doses. Since our smallest dose, 47.5 μ c on the fifth day of incubation, destroyed the spermatogenic cells, and 180 μ c on the fourth day caused no primary injury to the somatic testicular cells, it appears that the spermatogenic cells are at least five times as radiosensitive as the somatic testicular cells.

Several weeks after the primary radiation destruction of the germ cells, retarded tubular development and testicular growth became evident. These changes were of almost constant magnitude, regardless of amount of radiation, and they persisted long after any significant amount of radiation remained. These facts suggest that the later changes may be a secondary effect caused by loss of primitive germ cells rather than by actual radiation injury to the remaining structures.

The absence of development of secondary sex characteristics in the male birds irradiated during incubation suggests either a decrease in or an abnormality of the androgen secreted.

Ovary The germ cells of the ovary are extremely radiosensitive, as are those of the testis. The other elements show only minimal changes, which may not be attributed to radiation. The degree of injury, however, unlike that of the testis, is determined by the amount of radiation and the age at which the ovary is irradiated. In the testis the effect was the same at the time of hatching whether

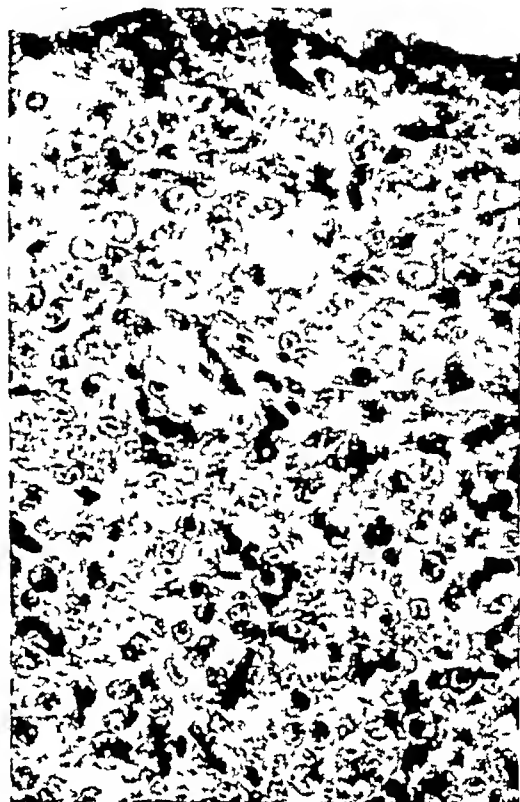


Fig 9 Section through cortex of ovary from normal fifteen-day embryo. The cortex occupies approximately the upper half of the picture and is filled with large germ cells with large, pale nuclei. The surface is covered with several layers of small cuboidal epithelial cells. The medulla is made up of rather uniform cells, closely packed. $\times 600$

47.5 or 300 μ c were injected into embryos. The ovaries, on the other hand, showed a definite variation, indicating that the older germ cells were distinctly more resistant. A dose of 47.5 μ c on the fifth day of incubation destroyed all ova and caused a moderate ovarian atrophy at hatching time sixteen days later. In a four-day embryo 120 μ c caused nearly complete destruction of ova nine days later (Fig 11). This damage was permanent. Fifty-one days after hatching, the ovaries were atrophic, no ova could be found, only occasional clusters of follicular epithelium being present. The medulla was diminished in size, but structurally normal. On the other hand, 100 μ c on the fourteenth day of incubation resulted in only a partial depletion of ova four days after injection (Fig 10), one-third to one-fourth the

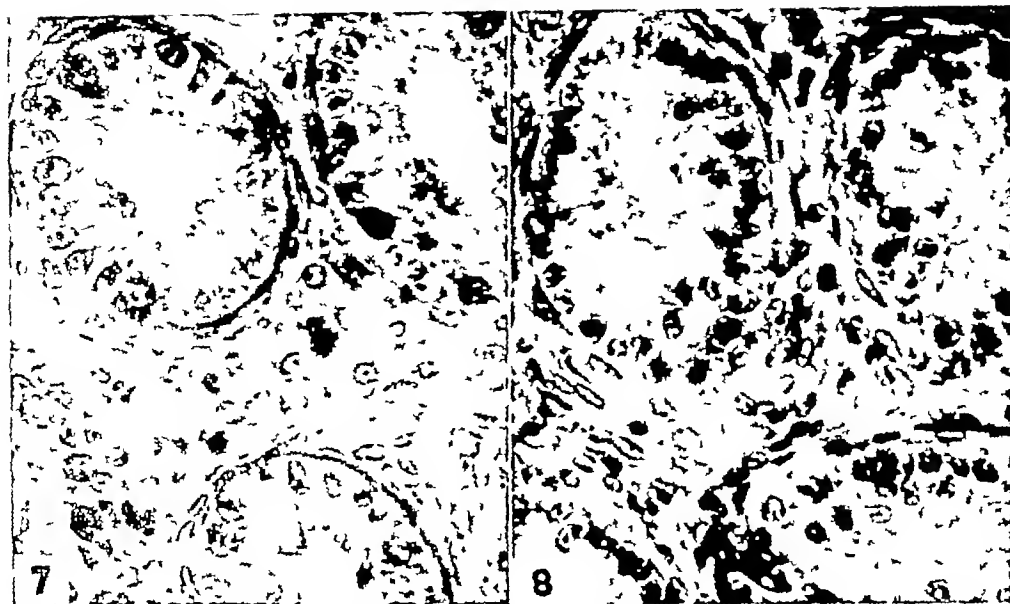


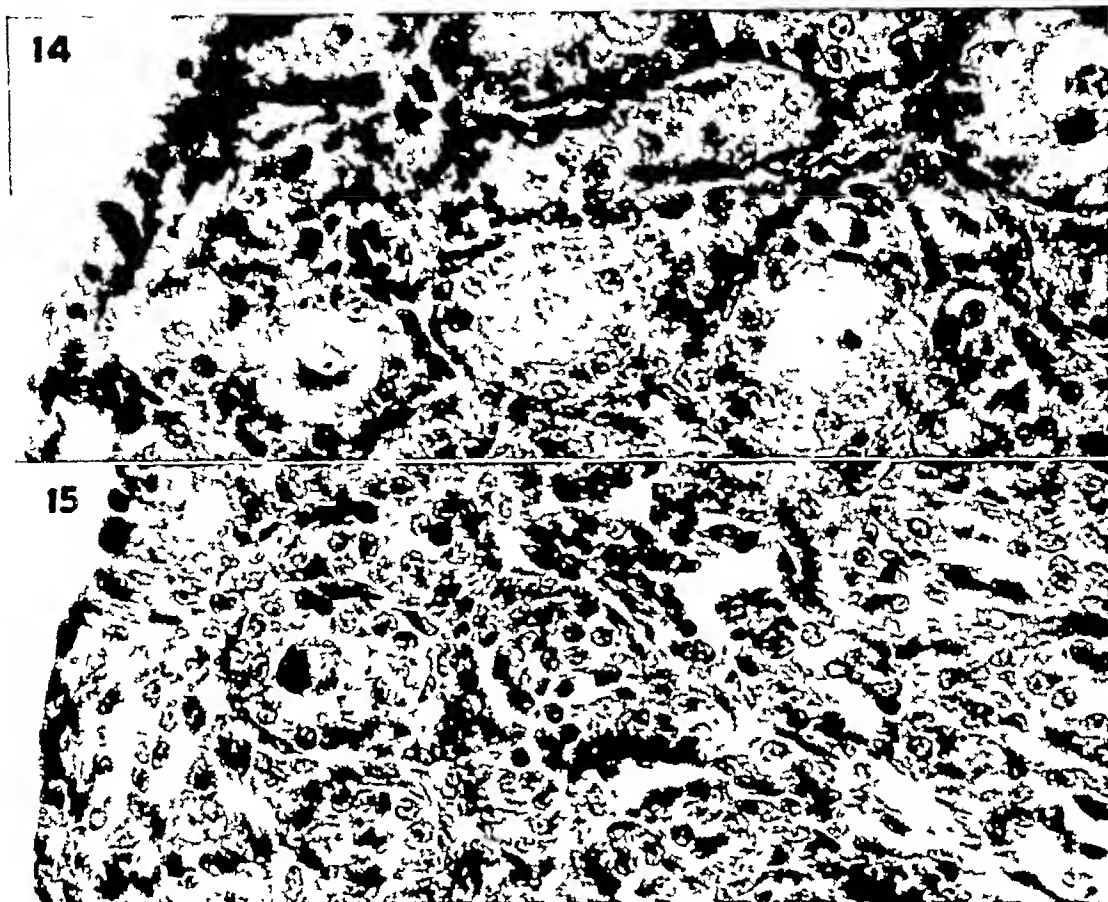
Fig 7 Testicular tubules from normal seven week chick. Tubules are lined by columnar epithelium and contain germ cells with large nuclei and dark cytoplasm. Interstitial tissue is composed of loosely arranged connective-tissue cells. $\times 600$

Fig 8 Testicular tubules from fifty-four-day chick given $100 \mu c$ on eighth day of incubation. Germ cells are absent, tubules have small lumens, and lining cells are markedly vacuolated. Interstitial tissue is slightly more condensed than normal (Fig 7) and the nuclei are smaller. $\times 600$

injection of $200 \mu c$ on the fourteenth day of incubation, the only gross testicular abnormality was a slight diminution in size. The histologic changes consisted of loss of germinal epithelium and some tubular atrophy. The testes were one-half normal diameter thirty-nine days after injection of a four-day embryo with $120 \mu c$. The tubules were narrowed, and there was loss of spermatogenic cells, but the normal columnar epithelium and the basement membrane were unaltered. The interstitial cells were also normal in structure. The stroma appeared slightly condensed, suggesting atrophy. The most advanced changes were noted from six to seven weeks after administering $100 \mu c$ to eight-day embryos (Fig 8). The testes were one-third to one-half the normal diameter, the tubules were atrophic, the lumen small and void of spermatogenic cells, the columnar lining cells showed cytoplasmic vacuoles of doubtful significance, the basement membrane was less distinct than normal, the stroma appeared slightly condensed, but the interstitial cells were normal in structure and distribution.

In the chicks injected subcutaneously with P^{32} after hatching, the same destruction of spermatogenic cells with similar minor changes in other testicular elements was seen. Forty-eight hours after injection of $180 \mu c$, the testes of a four-day male chick had lost nearly all of the spermatogenic cells, only a few degenerating forms were still visible. The tubular epithelium and interstitial cells showed some hydropic change, and there was moderate interstitial edema, changes characteristic of acute radiation reaction. Observations from four to forty-eight days after injection revealed no edema or hydropic changes. The loss of spermatogenic cells was constant and was the only testicular change apparent during the first week after injection. Several weeks later, atrophy of the testicle became apparent and the changes were the same as those seen in the irradiated embryos examined a number of weeks after hatching.

In none of the male birds irradiated during incubation did secondary sex characteristics develop during the sixty-day observation period. At two weeks the



Figs 14-15 Portion of ovarian cortex with numerous ova from normal fifteen-day chick is shown in Figure 14. Figure 15 shows ovary of moribund fifteen day chick given 200 μ c on fourteenth day of incubation. Note thin cortex of latter, occupying only about one-fourth of the field and containing a single ovum. $\times 600$

tion Three days after injection, one-half to two-thirds of the cortical germinal cells were destroyed and mitotic activity was reduced, with resultant thinning of the cortex. There was as yet little apparent change in the medulla. Ovaries of these embryos examined ten and twelve days after injection were small and had cortices containing about one-third the normal number of germinal cells. The medullae were correspondingly small but histologically negative. These birds died from severe anemia within fifteen days after hatching. The ovaries at death contained an estimated one-tenth to one-twentieth of the normal number of ova with little mitotic activity in the germinal epithelium. The medullae were markedly hypoplastic. Such an irradiated ovary and a normal one are compared in Figs 14 and 15.

Repeated subcutaneous injections of P^{32} in birds after hatching had a destructive effect on young ova and an inhibitory effect on maturing ova proportionate to the amount of P^{32} given, but radiation heavy enough to cause fatal anemia did not destroy all ova. The early effect of such injection on young ova was clearly seen in a chick one day old injected with 170 μ c P^{32} and killed twenty-four hours later (Fig 13). The cortex had lost approximately one-half to two-thirds of its primitive germ and epithelial cells and was in some places collapsed and in others edematous. The remaining ova and epithelial cells varied in degree of hydropic change, pyknosis of nuclei, and irregularity of cellular outline. The medulla was not obviously affected by this twenty-four-hour exposure. From observation on birds

living several weeks following irradiation, it was seen that some of these spared ova would grow but would be smaller than normal. The medullae were retarded in proportion to the injury to the ova. The effect in the older birds was to inhibit growth of large ova and destroy at least part of the very young ova. In no case did we see the cellular response to free lipid which one would expect if the more mature ova with much stored lipid were destroyed.

Discussion In the ovary the primitive ovum was the most radiosensitive element. However, the age of the ova was an important factor in determining response to radiation. All injections of P^{32} during the first eight days of incubation, the smallest being 47.5 μ c, destroyed the ova. All injections made on and after the fourteenth day of incubation, in spite of delivering more radiation to the ovary than the earlier injections, failed to destroy all ova. For example, 200 μ c on the fourteenth day of incubation delivered, during the remainder of incubation, approximately twice as much radiation as came from 47.5 μ c given on the fifth day of incubation, yet the larger dose failed to destroy all the ova as the smaller dose had. Another example was seen in chicks injected with fatal and near-fatal amounts of P^{32} after hatching. Only partial destruction of the most immature ova and temporary inhibition of the developing ova occurred in these older birds, in contrast to the complete destruction of all ova in the embryos injected early in incubation with much less than lethal doses. This would suggest that, as the chick ovum matures and takes on increased intercellular material, it becomes more resistant to irradiation.

No cytologic changes were observed that would suggest direct radiation injury of the stromal cells. A week or so after the radiation injury to the ova, the remainder of the ovary was hypoplastic but histologically showed no evidence of radiation injury. The extent of this hypoplasia was proportional to the degree of injury to the ova and remained after the signifi-

TABLE III AVERAGE LENGTHS AND WEIGHTS OF TIBIAS FROM CONTROL AND IRRADIATED CHICKS EIGHT WEEKS OLD (See Fig. 16)

	Weight (gm.)	Length (cm.)
Control	2.96	8.9
235 μ c 6 days after hatching	2.5	8.1
760 μ c 29 days after hatching	2.38	8.0
100 μ c on fourteenth day of incubation	2.06	7.9
100 μ c on fourteenth day of incubation plus 1,050 μ c 37 days after hatching	1.75	7.6

cant irradiation had ceased. On the basis of these observations, it seemed possible that the ovarian hypoplasia which appeared some time after irradiation was dependent upon the changes in the ova and was not a direct result of radiation injury.

The female chicks irradiated during incubation did not show the lack of secondary sex characteristics seen in the male birds. However, such a change would be more difficult to detect in females, since a castrate bird in its lack of secondary sex characteristics resembles a female much more closely than a male.

The atrophy of the right ovary, which takes place during the latter part of incubation, did not resemble the atrophy following irradiation in that the latter showed primary early injury of the ova followed later by stromal atrophy, while the naturally occurring atrophy involved all ovarian elements simultaneously.

4 *Effect of Radiation on Bone* The bone of developing embryos and chicks received heavier and more prolonged irradiation than did other tissue. P^{32} injected into the yolks of eggs early in incubation was relatively uniformly distributed throughout the embryo until after the ninth day of incubation, when calcified bone first forms. From then on, the P^{32} concentrated in the bone. Within the various parts of any given bone there was a significant difference in intensity of radiation. Concentration of P^{32} was directly proportional to the degree of calcification as evidenced by severe marrow injury in well calcified parts of bone and relatively little injury in the cartilaginous parts.



Fig 16 Left tibias from 7-week chicks grouped as follows 1 Controls 2 235 μ c six days after hatching 3 780 μ c twenty-eight days after hatching 4 100 μ c on eighth day of incubation 5 100 μ c on eighth day of incubation plus 1050 μ c twenty-nine days after hatching

In spite of marked radiation effects, the bones maintain a normal shape, with no bowing or epiphyseal deformities. The pale color of bones in Group 5 is due to complete destruction of marrow and severe anemia (Length and weights given in Table III)

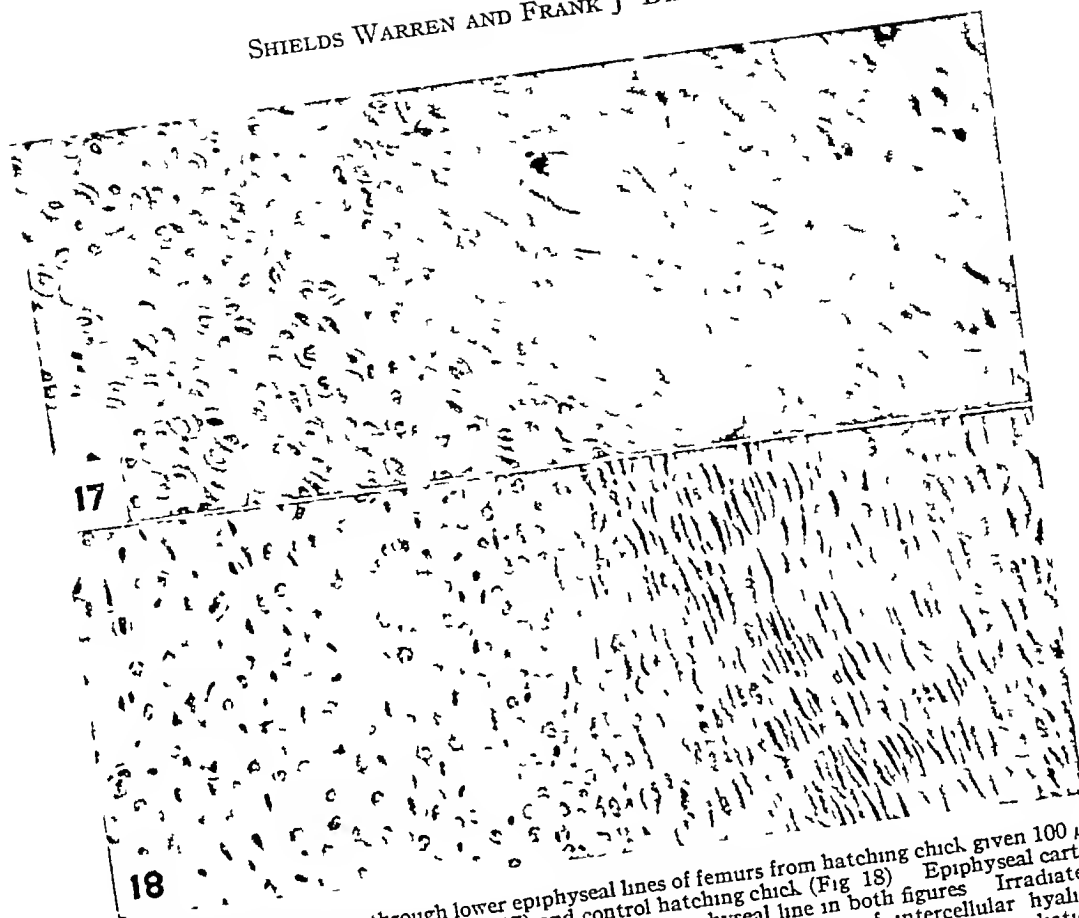
Gross examination showed the bones of embryos and chicks receiving radiation to be shorter and lighter than normal (Table III). The bones irradiated during incubation were much thinner and lighter than those irradiated later in life. In birds receiving sufficient irradiation to produce destruction of the marrow elements, the bones appeared pale white and almost translucent rather than normal gray-brown and opaque. There were no deformities, and the dwarfed bones retained normal proportion and structure (Fig 16).

The ends of the tibia and femur making up the knee joint were used in the microscopic observations of radiation injuries to the bones because they could be easily cut and blocked to give comparable sections and because these bones continued to grow throughout our period of observation.

The radiation effects on developing bones were essentially the same whether the injection was into embryos or chicks. The rapidly dividing cartilage cells in the proliferating zone and epiphysis were the most radiosensitive. The effect on osteoblasts and osteoclasts was not obvious from cytologic studies, although there was some retardation of bone formation as evidenced by the thin cortical bone and reduced number of bony lamellae, which were

nevertheless somewhat larger than normal.

Effects of various amounts of radiation on the bone development in embryos will be discussed first. The smallest dose used in studies of bone was 100 μ c, injected on the fourteenth day of incubation. Effects were visible in both cartilage and bone four days later. The outstanding reaction was seen in the zone of proliferating cartilage. Chondrocytes were clearly injured. Mitoses were about 25 per cent of normal and the cells were elongate and irregular in shape. Changes in the bone were less striking and might be considered equivocal. The periosteal osteoblasts appeared smaller and less active than normal, and the cortical bone of the shaft was slightly thinned. Three days later, seven days after injection, the suppression of mitotic division and the abnormalities in shape of the injured chondrocytes were more marked. Chondrocytes were fewer in number, swollen, indistinct, and irregularly distributed. As a result, the zone of proliferation was thin and the lacunae of the epiphysis were enlarged. This stage of injury and the normal appearance may be compared in Figures 17 and 18. At this time the differences in size between normal and irradiated bones began to be apparent, suggesting an alteration in osteoblastic and osteoclastic activity. This same process continued, and three days later, ten



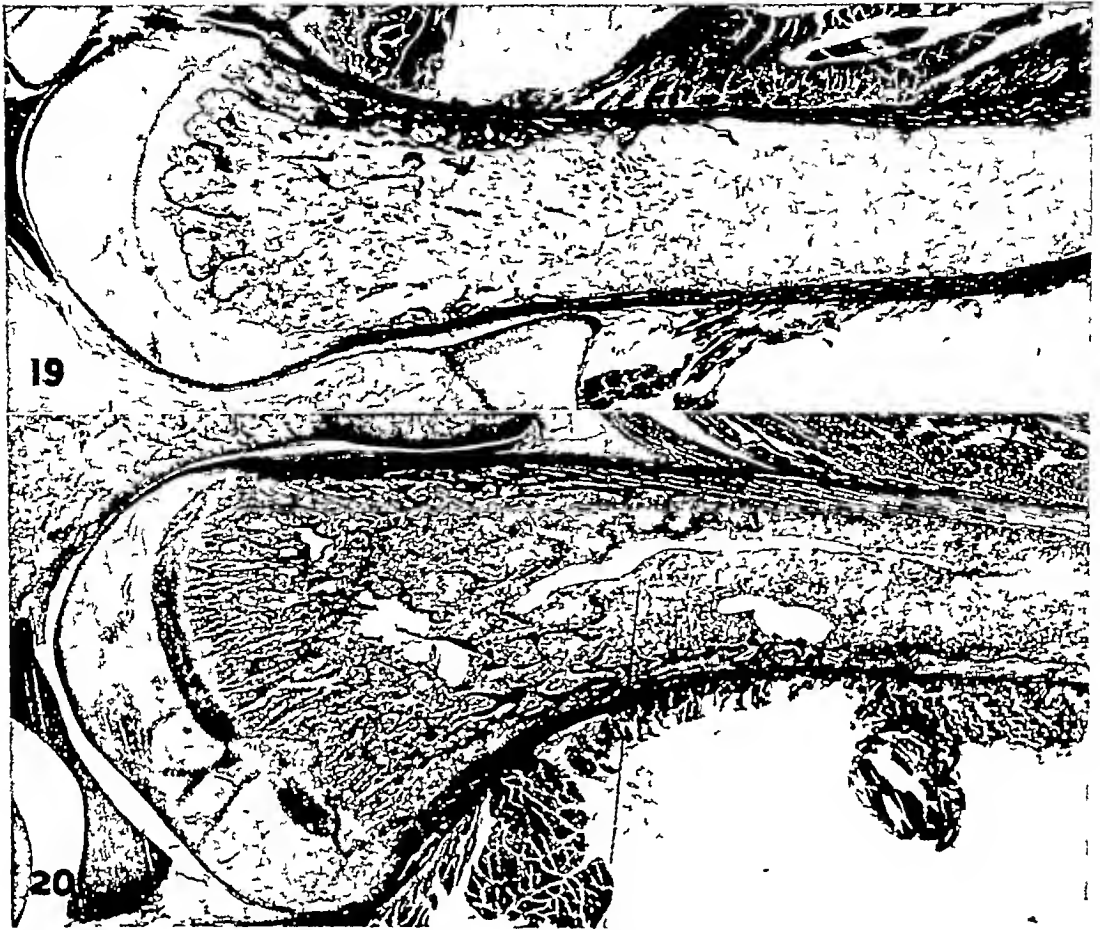
Figs 17-18 Sections through lower epiphyseal lines of femurs from hatching chick given 100 μ c on fourteenth day of incubation (Fig 17) and control hatching chick (Fig 18) Epiphyseal cartilage is to left and proliferating cartilage is to right of epiphyseal line in both figures Irradiated epiphyseal chondrocytes have enlarged lacunae and decreased amount of intercellular hyaline The epiphyseal line is less sharp in the irradiated bone In the proliferating cartilage radiation caused swelling and granularity of the cells and decreased cell division $\times 400$

days after injection, in addition to the structural abnormalities of the chondrocytes and the sluggish rate of mitosis, there was a loss in the amount of hyaline intercellular matrix in the epiphysis

After the tenth day there was an increase in mitotic activity in the epiphysis and zone of proliferation, but an irregular arrangement of epiphyseal chondrocytes and a subnormal amount of hyaline matrix persisted In a fifteen-day chick, the processes of cartilaginous resorption from the shaft and accompanying provisional calcification appeared to have exceeded the diminished cartilage proliferation, and the resorption of cartilage and provisional calcification were much closer to the epiphyseal line than in the normal The osteoblasts and osteoclasts appeared normal, although the calcified shaft of the bone was still slightly thin The bones of

chicks examined seven weeks after hatching were significantly smaller than normal (Table III), but their histologic structure was not remarkable Approximately the same amount of radiation to a younger embryo produced a similar but slightly more marked reaction and retarded recovery However, even these changes resulting from severe prolonged suppression of growth were reversible, and in a chick of this series killed at fifty-one days of age the bones, while abnormally small, were histologically normal

The most marked effect was observed following injection of 200 μ c into eight- or fourteen-day embryos, a dose which was fatal fifteen days after hatching, but the changes were the same type as those seen in the less heavily irradiated birds At hatching time, seven to twelve days after injection of 200 μ c, the cartilage cells of



Figs 19-20 Lower end of femur of fifteen-day chick given 200 μ c on eighth day of incubation (Fig 19) compared with normal of same age (Fig 20) The irradiated specimen is small and shows a very narrow zone of proliferating cartilage adjacent to the epiphyseal line Nearly all of the vesicular cartilage beyond the proliferating zone has been resorbed and replaced by only a few bony trabeculae in the zone of provisional calcification The cortex of the irradiated shaft is very thin and the marrow cavity is devoid of blood-forming cells $\times 12$

the epiphysis were irregular in size, shape, and distribution. Some of the cells were swollen and stained poorly, and the cell boundaries were not visible as in the normal. They showed little, if any, mitotic activity, and many of the lacunae were enlarged. These abnormalities were more marked in the zone of proliferating cartilage which, nevertheless, was normal or only slightly decreased in thickness. There was less osteoblastic and osteoclastic activity in the shaft, resulting in fewer bony trabeculae in the center of the shaft and slight thinning of the cortex with a decreased number of lamellae, which appeared somewhat thicker than normal. In the moribund fifteen-day-old chicks the epi-

physeal cartilage cells were irregularly placed, they showed little mitotic activity, and intercellular hyalin was markedly diminished. The zone of proliferating cartilage was one-third to one-half normal width and showed no mitotic activity. The cartilage resorption from the shaft had exceeded the limited cartilage proliferation and extended to the limits of the zone of proliferation. Osteoblastic and osteoclastic activity in the shaft was markedly reduced and the cortical bone was thin. A section through the lower end of the femur of one of these moribund birds is compared with a normal of the same age in Figures 19 and 20.

The changes in bone development caused

by injection of P^{32} into young chicks depended upon the size of the dose of radiation and the age of the chick at time of injection. The injury to the cells, however, followed the same pattern described in the irradiated embryos. Slight early changes were seen in a bird injected subcutaneously with 235 μ c when six days old and killed two weeks later. The epiphyseal cartilage showed reduced mitotic activity but was otherwise negative. The zone of proliferating cartilage was two-thirds normal width and showed a reduced number of mitoses. The amount of unresorbed cartilage was normal, which indicated that, considering the apparently reduced rate of cartilage proliferation, the resorption must also be slowed. The provisional calcification also appeared to be lagging slightly. Finally, the cortex of the shaft of the long bone was slightly thinner than normal and osteoblastic and osteoclastic activity was somewhat decreased. A more advanced stage of this process was seen in a chick given 300 μ c on the twenty-ninth day and killed on the forty-third day. The epiphyseal cartilage had recovered and was negative. The zone of proliferating cartilage was slightly narrowed and still showed some reduction in mitotic activity. The cartilage beyond the proliferating zone had been resorbed almost completely because of greater inhibition of cartilage growth than resorption. There was accompanying provisional calcification much closer to the epiphyseal line than in the control. Decreased osteoblastic and osteoclastic activity were evident in the thinned cortex. Fatal courses of P^{32} , 1,118 μ c and 3,696 μ c, given to young chicks produced severe damage to the chondrocytes. In the proliferating zone of epiphyseal cartilage, which was only one-third to one-half normal thickness, the few remaining cells were swollen and pale, lying in the hyaline matrix with no vestige of normal columnar pattern. All cartilage beyond this narrow inactive proliferating zone had been resorbed, and a rather smooth, ossified line marked the edge of the proliferating car-

tilage. Osteoblastic and osteoclastic activity had ceased completely. The cortex of the shaft was thinner than normal, and the lamellae were fewer but somewhat thicker than normal.

Discussion The concentration of P^{32} in calcified bone produced more prolonged and intense radiation in the skeleton than in soft tissues. The result was an obvious retardation in growth without, however, any distortion of the gross appearance of the bone. The birds that survived heavy doses were found weeks later to have bones of normal histologic structure, although they were dwarfed. The effects were essentially the same in embryos and growing chicks. The cartilaginous epiphysis and especially the zone of proliferating cartilage were most sensitive to radiation, while osteoblasts and osteoclasts were relatively resistant.

The earliest histologic effects of radiation, which appeared within a few days, were the cessation of mitotic activity and irregular swelling, vacuolation, and granularity of the chondrocytes. As the radiation continued, there was a decrease in intercellular hyalin of the cartilage, an irregularity in distribution of the cartilage cells of the epiphysis, and a narrowing of the zone of proliferating cartilage, with swelling and degeneration of the cells.

The processes of cartilaginous resorption in the shaft and accompanying provisional calcification were not as completely inhibited by radiation as was the proliferative process. Thus, after a prolonged period of irradiation, all the vesicular cartilage was resorbed and a strip of provisional calcification was laid down along the thin and inactive zone of epiphyseal cartilage.

The bone formation in the shaft was also retarded, as evidenced by the thin cortical bone made up of a reduced number of bony lamellae which tended to be larger than normal. This change in cortical bone suggests a reduction in osteoblastic and osteoclastic activity which normally is responsible for the definitive modeling of the bone structure.

This injury was reversible even when

extreme and, after the activity of the retained P^{32} decreased to a point of insignificance, cartilaginous proliferation was resumed and the rest of the bony architecture returned to normal. Growth proceeded apparently unimpaired from then on, for in chicks several weeks after the period of heavy radiation the bones were all but indistinguishable histologically from normal.

SUMMARY

Chick embryos and young chicks were exposed to continuous radiation by injections of P^{32} . The P^{32} concentrated largely in the bones of the embryos and chicks. The radiation caused an over-all growth retardation, resulting in small but well proportioned birds.

Both testes and ovaries were found to be among the most radiosensitive organs and were the least able to recover from injury. The primitive sex cells in either gonad were the most sensitive element. The spermatogenic cells of the testis remained extremely radiosensitive throughout their development, while the ova became more radioresistant as they matured. The somatic cells of the gonads were much more radioresistant than the sex cells, but their

rate of growth was inhibited following injury to the sex cells.

Bone growth was retarded by radiation. The cartilage cells of the epiphysis were much more radiosensitive than the osteoblasts and osteoclasts. After radiation ceased, the bones regained a normal histologic structure but remained dwarfed.

NOTE: The authors are indebted to Dr. Olive Gates for invaluable assistance in the preparation of this work.

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SUMARIO

Efectos de la Irradiación Continua sobre los Embriones de Pollo y los Pollos en Vías de Desarrollo
I. Velocidad del Crecimiento, Gonados y Hueso

Embriones de pollo y polluelos fueron expuestos a la irradiación continua por inyecciones de P^{32} . El P^{32} se concentró en gran parte en los huesos de los embriones y pollos. La irradiación acarrió un retardo general del desarrollo, dando por resultado aves pequeñas, pero bien proporcionadas.

Tanto los testículos como los ovarios figuraron entre los órganos más radiosensibles, mostrándose como los menos capaces de reponerse de las lesiones. Las primitivas células sexuales de uno o otro gonado constituyeron el elemento más susceptible. Las células espermatógenas del testículo continuaron siendo suma-

mente radiosensibles durante todo su desarrollo, en tanto que los huevos se volvieron más radorresistentes a medida que maduraban. Las células somáticas de los gonados fueron mucho más radorresistentes que las sexuales, pero una vez lesionadas las últimas se inhibía la velocidad del desarrollo de las primeras.

Los osteogénia fué retardada por la irradiación. Las células cartilaginosas de la epífisis mostráronse mucho más radiosensibles que los osteoblastos o los osteoclastos. Después de cesar la irradiación, los huesos recobraron su histología normal, pero permanecieron empequeñecidos.

EDITORIAL

Radiation Protection

The matter of radiation protection for his patient and himself has long been of intimate concern to the radiologist. Almost from the first use of x-rays, and gamma rays from radium, there has been a certain degree of awareness of their potential danger if used carelessly, but it was not until about 1920 that serious numbers of radiation "burns" began to be evident. This coincided with the introduction of the Coolidge type of tube with its higher output and greatly expanded field of application, with consequent recognition of the need for even greater care in protection.

In 1928 the first set of radiation protection rules or recommendations was adopted on an international basis by the Second Congress of Radiology in Stockholm. In these rules agreement was reached on some of the broader factors involved, but since ready agreement on details was not attainable, these were left for future amplification by individual countries. It is of interest to note how little these 1928 rules have required alteration other than to cope with our rapidly extending horizon of available x-ray energies.

In 1929, an effort to amplify and extend the recommendations of the International Commission, suitable to the radiological needs of this country, was undertaken. Upon the recommendation of the International Commission on X-ray and Radium Protection, the Advisory Committee on X-ray and Radium Protection was formed by the Bureau of Standards and composed of representatives of the Radiological Society of North America, the American Roentgen Ray Society, the National Research Council, the American Medical Association, and x-ray and radium manufacturers. This group formulated the well known Handbooks on X-ray Protection in

1930 and 1935 and Radium Protection in 1938. These served as the major bases for later codes on industrial x-ray and radium protection and for the operation of the Manhattan District in its early days.

Need for revision of Handbook 20 on X-ray Protection was felt some years ago, but the war interfered with the work. When this revision was finally undertaken in 1947, it was realized that the problem of radiation protection had been so broadly expanded by the advent of atomic energy as to necessitate an enlargement and reorganization of the original committee. The sponsorship was enlarged to include representation of the Atomic Energy Commission and United States Public Health Service, and the name was changed to National Committee on Radiation Protection. It now comprises eight subcommittees to deal with the following subjects: permissible external exposure, permissible internal exposure, x-rays up to two million volts, gamma rays and electrons above two million volts, protons, neutrons and heavy particles, handling of radioactive isotopes, radiation instrumentation and measurement, waste disposal and decontamination. In addition to representatives from the parent organizations, the Committee has included in its membership outstanding authorities throughout the country on all phases of radiation protection. It is doubtful if a more experienced body of protection experts could be found.

The first of the new reports prepared by this Committee will be Handbook 41 on *Medical X-ray Protection Up to Two Million Volts*¹. This will be a complete revision of the earlier handbook. One of the

¹ This Handbook can be obtained from the Superintendent of Documents, Government Printing Office, at a cost of \$0.15 per copy.

major changes consists in a more detailed presentation of protective barrier requirements. In the international recommendations and previous handbooks a single table of lead thicknesses was given. These applied only to direct beam shielding at one meter from the tube under average operating conditions. Literal use of these figures often resulted in over-protection (particularly for scattered radiation) and excessive installation costs. The new recommendations take into consideration such factors as distance, tube output, scattered or direct radiation, different kinds of protective materials, etc. It should now be possible to design shielded installations affording adequate protection with substantial savings in cost.

Other handbooks on *The Safe Handling of Radioactive Isotopes*, *Permissible Exposure of the Body to External Radiations*, and *Radiological Instrumentation* are now nearing completion and announcements of their release will be made later.

The needs, interests, and assistance of the radiological organizations of the country have been essential in the preparation of these recommendations. Their continued help in the form of comments and suggestions is required in order that future handbooks may continue to serve the radiological profession in providing up-to-date data and methods in the field of radiation protection.

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SIXTH INTERNATIONAL CONGRESS OF RADIOLOGY

As announced in the March issue of *RADIOLOGY*, the Sixth International Congress of Radiology will be held in London from July 23 to July 30, 1950, under the presidency of Dr Ralston Paterson, of Manchester. The headquarters of the Congress will be at the Central Hall, Westminster, which will also house an extensive Scientific Exhibit. The Technical Exhibit of apparatus will be located in the Halls of the Royal Horticultural Society nearby.

The subjects chosen for the main scientific meetings are

- 1 *General Congress Scientific Meetings*
 - (a) Radiological Achievement, 1937-50
 - (b) Mass Radiology of the Chest
 - (c) Supervoltage Radiotherapy
 - (d) Radiation Hazards
- 2 *Diagnosis Section Symposia*
 - (a) Skeletal Changes in Blood Diseases
 - (b) Radiology of the Small Intestine
 - (c) Arthrography
 - (d) Angiocardiography
- 3 *Therapy Section Symposia*
 - (a) Method of Presentation of Results of Treatment
 - (b) Radioactive Isotopes
 - (c) Cancer of the Larynx
 - (d) Cancer of the Breast
- 4 *Biology Section Symposia*
 - (a) Radiation Histology
 - (b) Radiation Chemistry
 - (c) Radiation Genetics
 - (d) Mode of Action of Ionizing Radiations
- 5 *Physics Section Symposia*
 - (a) Acceleration of Particles and the Generation of Ionizing Radiations
 - (b) Radiological Units
 - (c) Radiotherapeutic Physics
 - (d) Production and Physical Properties of Radioisotopes

Selected speakers will be invited to contribute the major portion of these symposia. Other sessions will be devoted to the reading of papers proffered by authors on their own topics.

A varied and interesting social program is being arranged for members of the Congress, and special attention is being paid to the entertainment of Associates accompanying Members.

During the week preceding and the two weeks following the Congress, demonstrations will take place in the radiological departments of a number of London hospitals. Planned tours to centers of interest in Great Britain and Ireland are being arranged to follow the Congress. They will include

excursions to the neighboring countryside by coach, visits to buildings of historical interest, demonstrations at hospitals, and a full social program.

Those wishing to attend the Congress as Full Members (£7 7s 0d) or as Junior Members (under thirty years of age on Jan 1, 1950—£4 4s 0d) must be members of a radiological society, or sponsored by a radiological society. Ladies and children accompanying Members can be registered as Associate Members (£3 3s 0d). Associate Membership is also open to members of the technical staffs of radiological departments and laboratories, or of the x-ray industry. A late fee will be charged to those registering after April 1, 1950.

Members of the Congress may make their travel and hotel reservations through any office of Messrs Thomas Cook & Son, Ltd (or their associated company, the Cie Internationale des Wagons-lits), who have been appointed the official travel agents for the Congress.

It is planned shortly to issue a detailed program with registration forms to the members of radiological societies. All communications in connection with the Congress should be addressed to the Secretary-General at 45 Lincoln's Inn Fields, London, WC 2.

NOTE: It has just been learned that H R H the Princess Elizabeth hopes to open the Congress.

AMERICAN BOARD OF RADIOLOGY INSPECTION OF TRAINING FACILITIES

Since the formation of the American Board of Radiology in 1934, its members and sponsors have realized that the standards of its examination could not be raised higher than the standards of training in radiology. Prior to 1941 there was a marked paucity of available residencies, and during those years the primary effort was devoted to encouraging institutions to inaugurate residency training. In September 1941, the American Board of Radiology ruled that after Jan 1, 1945, no candidate would be admitted to examination who had not completed three years of residency training in an approved department of radiology. Unfortunately, on Dec 7, 1941, we were precipitated into World War II and our plans made only three months earlier went up in smoke.

Immediately after the war was over, our Board, along with all specialty boards, realized that there would be many young men returning from service demanding residency training, and in order to accommodate these young men, we entered into an agreement with the Council on Medical Education and Hospitals of the American Medical Association to make a cursory inspection of the applications sub-

mitted by any department of radiology and to give temporary approval for residency training until such time as the Board and the Council could review these programs

The time has now come when we consider this emergency to be over and we must put our house in order by raising the standards of training in radiology. There are many of the older institutions which have been approved for a great many years whose personnel in the department of radiology has changed considerably. Therefore, it has now been deemed wise by the Board to review all our residency programs, including those already approved, both permanently and temporarily, as well as those applying for approval.

The Council on Medical Education and Hospitals of the A M A has done an outstanding job in inspecting and evaluating the residency programs in all specialties and has co-operated harmoniously with the Boards. We therefore have no desire or intention of interfering with this fine work, but it has been decided, with the full approval of the Council, that the Board of Radiology will conduct its own inspection of all its residency programs. It is not our plan, however, to repeat this survey for many years, if at all.

Between forty and fifty outstanding radiologists with teaching experience have been invited to assist in making the inspection. Each department of radiology offering training in radiology, which is either already approved or seeking approval, will be visited by one of these men.

This program will require several months to complete and it is therefore hoped that those departments of radiology seeking initial approval will be patient with us until it is completed.

B R KIRKLIN, M D , *Secretary*

PENNSYLVANIA RADIOLOGICAL SOCIETY

The following is the program of the Thirty-fourth Annual Meeting of the Pennsylvania Radiological Society, at Bedford Springs Hotel, Bedford, Penna.

Friday, May 20

- 9 00 Address of Welcome
- 9 15 Film-Reading Session, George W Chamberlin, M D , Reading, Chairman
- 11 00 Use of Hyaluronidase in Subcutaneous Urography, John W Hurst, M D , Altoona
- 11 20 Cystitis Pneumatosus, Joseph T Danzer, M D , Oil City
- 11 50 Mucocoeles of the Frontal ethmoidal Sinuses, Russell Wigh, M D , Philadelphia
- 12 10 Roentgen Demonstration of Complications of Mastoid Disease, Barton R Young, M D , Philadelphia
- 2 00 Roentgen Therapy in Non-Malignant Gynecologic Conditions, Theodore P Eberhard M D , Philadelphia

- 2 25 A Type of Irradiation Effect in Metastasis to Cervical Lymph Nodes, Mary Helen Cameron, M D , and Andrew J Donnelly, M D , Philadelphia
- 2 50 Treatment of Cervical Metastases, S Gordon Castiglione, M.D., Philadelphia
- 3 15 Long Survival in Malignant Lymphoma, Edwin J Euphrat, M D , Pittsburgh
- 4 00 Fibrous Dysplasia of Bone, S P Perry, M D , Sayre
- 4 30 Business Meeting

Saturday, May 21

- 9 00 Film-Reading Session, Paul C Swenson, M D , Philadelphia, Chairman
- 11 00 Anatomy of the Tracheobronchial Tree, Gerald D Dodd, M D , Philadelphia
- 11 20 Experience with Cardiac Catheterization, Angiocardiology, and Thoracic Aortography, J Stauffer Lehman, M D , Philadelphia
- 12 00 Business Meeting
- 2 00 Lesions in the Upper Third of the Stomach, J H Harris, M D , Harrisburg
- 2 30 Primary Tuberculosis, John Caffey, M D , New York, N Y

ATLANTA RADIOLOGICAL SOCIETY

On March 11, 1949, at a called meeting of the radiologists of Atlanta, Georgia, the Atlanta Radiological Society was organized. Meetings of the new society will be held on the second Friday evening of each month except during the three summer months. The officers are: President, Dr J J Clark, Vice-President, Dr Charles A Privitera, Secretary-Treasurer, Dr W W Bryan, 490 Peachtree St, N E, Atlanta.

COMMONWEALTH LECTURES LOUISVILLE, KENTUCKY

Dr Merrill C Sosman, as Commonwealth Visiting Professor of Radiology, delivered a series of lectures at the Louisville General Hospital, April 4-8. His subjects were: Radiology of the Skull, Roentgenology in the Diagnosis of Heart Disease, Roentgenology in the Study of the Gallbladder, The Gastro-Intestinal Tract as Seen by the Roentgenologist, Some Observations on Cushing's Disease. On April 8, at a joint dinner meeting of the Louisville Medico-Chirurgical Society and the Louisville Radiological Society, Dr Sosman spoke on "The Historical Development of Our Knowledge of Pituitary Tumors."

ST LOUIS SOCIETY OF RADIOLOGISTS

At a recent meeting of the St. Louis Society of Radiologists, Dr Don C Weir was elected President and Dr Charles J Nolan, 737 University Club Bldg, St. Louis 3, Mo., Secretary-Treasurer.

VII^{ème} CONGRES DES MEDECINS ELECTRO-RADIOLOGISTES DE LANGUE FRANCAISE

The Seventh Congress of the French Speaking Electro Radiologists will be held at the Faculte de Médecine, Paris, October 10 to 15, 1949. Professor Paul Lamarque of Montpellier is President of the Congress. Other officers are Professor Maisin of Louvain, Belgium, Dr Dariaux of Paris, and Dr Proux of Paris.

TWENTY-FIVE YEARS OF RADIOTHERAPY BELLEVUE HOSPITAL, NEW YORK

The twenty-fifth anniversary of the establishment of the Radiation Therapy Department of Bellevue Hospital, under the direction of Dr Ira I Kaplan, was marked by a special clinical gathering of the department's alumni, on March 24, 1949, with lectures by Dr Bradley L Coley, on "Bone Tumors—A Field Requiring Co operation Between the Radiologist and the Surgeon," Dr Douglas A Quick, on "Advances in Radiation Therapy in the Past Twenty-Five Years," and Dr I C Rubin, on "Twenty-Five Years Experience with Irradiation Treatment for Sterility Associated with Habitually Delayed Periods." Luncheon was followed by a clinical demonstration of the work of the department, and the celebration concluded with a testimonial dinner to Dr Kaplan.

BROOKHAVEN NATIONAL LABORATORY NUCLEAR REACTOR

The construction of a nuclear reactor (atomic pile) and auxiliary laboratories is nearing completion at Brookhaven National Laboratory, and initial operation is expected in the Fall of 1949. The reactor has been designed to provide a unique facility to serve the needs of the scientific, engineering, and industrial institutions located in the northeastern part of the United States.

The reactor is an air-cooled unit constructed of graphite and unenriched uranium. The maximum thermal neutron flux is expected to be about 5×10^{12} neutrons per square centimeter per second. For experiments, one hole 12 in square, and several 4-in square holes penetrating the shield at various levels, will permit the insertion of apparatus in the interior of the reactor and the release of collimated neutron beams. The over-all width of the reactor, including the shield, is about 38 ft. in the direction of the 4-in openings. A number of automatic devices will allow controlled irradiation of samples for periods as short as ten seconds. The top shield of the reactor consists of removable 4-ft square blocks. It will accommodate thermal columns and large equipment designed to utilize leakage thermal neutron flux (in excess of 10^{11} neutrons per square centimeter per second). Provision has been made

for cages in which large size laboratory animals can be moved under the reactor. It will be possible to conduct research on three vertical faces of the reactor, as well as at the top and bottom.

Laboratories specially designed for handling radioactive materials are included in the reactor building. They will accommodate more than eighty scientists and technicians for research in physics, chemistry, biology, and medicine.

A "hot" laboratory is being constructed near the reactor building, linked with the latter by a monorail and by pneumatic tubes for transporting irradiated material. Its completion, however, will be deferred until after the completion of the reactor.

Letter to the Editor

WORKMEN'S COMPENSATION SETTLEMENT BARS MALPRACTICE SUIT

To the Editor of Radiology

DEAR DR. DOUB:

I believe that your readers will be interested in a decision recently given out by the Supreme Court of New Jersey to the effect that acceptance of a personal injury award under the Employers Compensation Law bars recovery for alleged malpractice.

An employee of an aeronautical corporation in Jersey City, N J, received an injury to several fingers of her right hand and was cared for by the physicians who were treating injuries to the plant's employees. The patient received and accepted the compensation awarded for the injury and settled for the same.

Later she brought suit against the physician who attended her in the injury to her hand, claiming dissatisfaction with the end-result and alleging that the plant physician had been negligent in the diagnosis and treatment.

The trial court rendered a verdict for the plaintiff, and the case was appealed to the Supreme Court.

The New Jersey Supreme Court, after reviewing the case, decided that the Workmen's Compensation Act implies liability for compensation on the employer, regardless of fault, and provides a remedy to employees for accidental injury or injuries arising out of and in the course of employment. Accordingly full compensation was paid by the employer and accepted by the employee for the disability attributable to her injury. "She is entitled," said the Supreme Court, "to only one satisfaction for that injury. If that injury was aggravated by any alleged negligence of the physicians the remedy provided by the Compensation Act is inclusive and is covered. Any aggravation of the original injury not caused by an independent intervening act is considered compensated. The employee's right of action for the alleged negligence against the physicians was therefore barred by the acceptance of the compensation."

award" [Burns vs Vilardo, 60 Atl R (2nd) 94 New Jersey 1948]

This is a very important and far-reaching decision and tends toward placing the physician in a better position in cases of alleged late bad results of medical care, following personal injuries growing out of employers liability injuries. This type of injury is and has been a very fruitful one for ambulance-chasing lawyers and their money-grasping clients.

I S TROSTLER, M D
Chicago, Ill

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE FUNDAMENTALS OF PULMONARY TUBERCULOSIS AND ITS COMPLICATIONS FOR THE STUDENT, THE TEACHER, AND THE PRACTICING PHYSICIAN. Sponsored by the American College of Chest Physicians. Editor, EDWARD W HAYES, M D. Editorial Committee, Andrew L Banyai, M D, Herman Hilleboe, M D, J Arthur Myers, M D, and J Winthrop Peabody, M D. Twenty eight authors. A volume of 480 pages, with 182 illustrations and 2 color plates. Published by Charles C Thomas, Springfield, Ill, 1949. Price \$9.50.

Book Reviews

NEOPLASMS OF BONE AND RELATED CONDITIONS. THEIR ETIOLOGY, PATHOGENESIS, DIAGNOSIS, AND TREATMENT. By BRADLEY L COLEY, M D, Attending Surgeon, Bone Tumor Department, Memorial Hospital for Cancer and Allied Diseases, Assistant Professor of Clinical Surgery, Cornell University Medical College. A volume of 766 pages, with 622 illustrations and 53 tables. Published by Paul B Hoeber, Inc., New York, 1949. Price \$17.50.

In this work on Bone Neoplasms, Dr Coley has supplied a long-felt need for the radiologist and others upon whom falls the responsibility for the diagnosis and care of these lesions. It is a veritable storehouse of information, not only on the true neoplasms of bone, both benign and malignant, but also on other conditions affecting the skeletal system which may cause confusion in diagnosis. The contents reflect the wide experience of the author in this field and epitomize the information gleaned from a study of the vast material of the bone tumor department of New York's Memorial Hospital. The work will be of inestimable value to the radiologist, to all clinicians, and in particular to the orthopedic surgeon, with whom the final decision as to therapy so often rests.

The scope of the work is suggested by the titles of the Sections into which the text is divided: Classification, Etiology, and Diagnosis, Benign Tumors and Tumorlike Lesions of Bone, Primary Malignant Tumors of Bone, Tumors Involving Bone by Extension, Metastatic Tumors Involving Bone, Tumors of Bone in Special Localities. Surgical Treatment, Radiation Therapy, Constitutional Therapy, Lesions of the Skeletal System That May Simulate Neoplasms of Bone. A final section, headed Miscellaneous, takes up pathologic fractures, the medicolegal aspects of trauma in connection with bone tumors, and the experimental production of bone sarcoma.

In general, the author has stressed chiefly the clinical aspects of bone tumors, with somewhat less attention to the microscopic pathology. The chapter on Osteogenic Sarcoma is a good example of his method. Beginning with the classification of the Bone Sarcoma Registry and a brief description of each type of tumor, he goes on to a consideration of the clinical features, the differential diagnosis, a critical discussion of the various forms of therapy, and remarks on prognosis, with an analysis of cases treated at Memorial Hospital. Under Unusual Forms of Osteogenic Sarcoma he takes up Albers-Schönberg disease, extraskeletal osteogenic sarcoma, of which he reports an interesting case, osteogenic sarcoma arising in benign bone lesions, and osteogenic sarcoma developing after fracture. A discussion on sarcoma in irradiated bone completes the chapter.

The volume is well bound, attractive in format, and amply illustrated, with valuable bibliographies following each section and an adequate index.

NEURORADIOLOGY. By ALEXANDER ORLEY, M D, F F R, D M R & E, Hon Consulting Radiologist, West End Hospital for Nervous Diseases, London. A volume of 422 pages, with 572 illustrations. Published by Charles C Thomas, Springfield, Ill, 1949. (In England by Blackwell Scientific Publications, Ltd, Oxford. In Canada by the Ryerson Press, Toronto.) Price \$11.50.

This compact and readable treatise on neuroradiology is based on the author's ample experience in the Hurstwood Park Neurological Hospital and the West End Hospital for Nervous Diseases in London.

The various x-ray techniques and diagnostic findings are covered in a well organized manner. Many of the radiographic reproductions, however, suffer from the usual lack of detail, accentuated occasionally by inadequate labeling.

Cerebral angiography, arteriography, peripheral arteriography, ventriculography, and encephalography are covered in sufficient detail. When opportune, clinical statistics are discussed, particularly in the chapters on brain tumors and prolapsed intervertebral disks. In addition to the skull, spinal x-ray pathology, myelography, and the various neuropathic disturbances receive adequate mention.

The style is easy and free flowing. Adequate, but not exhaustive, coverage is made of the subject matter. An extensive bibliography is included. This is a desirable book for the neurologist and neurosurgeon as well as for the radiologist.

CAMPBELL'S OPERATIVE ORTHOPEDICS Editor, J. S. SPEED, M.D., Associate Editor, HUGH SMITH, M.D., Memphis, Tenn. Two volumes of 1644 pages, with an index of 44 pages, and with 1141 illustrations, including 2 color plates. Published by C. V. Mosby Co., St. Louis, Mo., 2nd ed., 1949. Price \$30.00.

The new edition of Campbell's *Operative Orthopedics* represents a formidable amount of information, clinical experience, and surgical technique. In its pages the resident in training will find elementary data well outlined, while the clinician will have several methods from which he can select the procedure most applicable to his problem.

The work has been completely revised, with the addition of new chapters on Fractures, Peripheral Nerve Injuries, Amputations, and Cerebral Palsy. The subjects of fracture care, arthrodesis, arthroplasty and correction of deformities are well treated. Various accepted techniques are described in detail. The advantages and indications of each one are noted. Especially worthy of mention is the section on the Nervous System, which includes the corrective procedures for paralyses, such as poliomyelitis, and the excellent description of cerebral palsy as conceived by Dr. Phelps. The discussion of scoliosis brings out the latest concepts of that condition. Hand surgery is wisely omitted for the most part, as this subject could not be presented adequately in a treatise of this scope.

This Second Edition of a standard work represents one of the best reference sources available for the graduate student and the surgeon. The illustrations with their context not only add to the appearance of the volumes, but also enhance their value to the reader. A well organized index and bibliography are included.

With three exceptions, the contributors are staff members of the Campbell Clinic. Doctors Speed and Smith have produced a well arranged and well executed piece of work. These volumes, justly dedicated to Dr. Campbell, will stand as a monument of which he would have approved.

ANATOMIE RADIOLOGIQUE NORMALE OPTIQUE RADIOLOGIQUE ET DIPISTAGE DES ERREURS DE LECTURE DES CLICHES By HENRY TILLIER, Electroradiologist des Hôpitaux d'Alger. A volume of 234 pages, with 350 figures representing tracings of films. Published by G. Doin & Cie, 8 Place de l'Odeon, Paris, France. Price 600 fr.

The author, after describing the well known principles of radiologic optics, applies his method of

careful analysis by the tracing of films to the study of normal cases, stressing the instances where the x-ray images may be misleading and describing in detail the optical causes.

The book is divided into eleven chapters. The first refers to the laws of radiologic optics. The next three deal with the upper and lower extremities, including the shoulder and the hip. The fifth chapter describes the spine, the sixth the bones of the thorax, and the seventh the pelvis. The eighth chapter deals with the head, including the development of its bones and their relations to the contents of the cranium. Subsequent chapters deal with the thoracic organs—lungs, heart, and great vessels—and the digestive tract, the organs related to the digestive system, such as the liver, the gallbladder, and the spleen, with the use of contrast media whenever possible, and the urinary and genital organs.

In each one of his descriptions the author emphasizes the regions which generally cause the greatest difficulties of interpretation, pointing out possible sources of error in the interpretation of normal structures. In the case of the skeleton, he stresses such regions as the face, the petromastoid region, and the base of the skull. In his discussion of the thoracic organs he points out the structures of the hilus of the lung, the projection of the cardiac cavities in different views, and the shadows of the great vessels. In the colon, the ceco appendicular and terminal ileum region are carefully described. As to the urinary and genital organs, special reference is made to descending and ascending urography and the aspects of the uterus, fallopian tubes, and ovarian regions, studied by means of opaque oil.

The originality of this book lies in the painstaking tracings of some 30,000 films which are the basis of the work. Reproductions are all of these tracings, without a single one of the original films.

The tracings are very accurately done, stressing the images that tend to cause confusion, especially when irregular planes coincide, as projected on a film. In cases of doubt this book will prove useful for reference, and comparison of the film with the accurate tracing of the normal film should be a valuable aid in reaching a correct conclusion.

DIE DURCHLEUCHUNGSTECHNIK DER THORAXORGANE [The Technic of Fluoroscopy of the Chest] By E. A. ZIMMER, Privatdozent of the University of Basel and Chief of the Roentgen Institute and Institute for Physical Therapy in the Cantonal Hospital of Fribourg. A volume of 120 pages, with 66 illustrations. Published by Benno Schwabe & Co., Basel, 2d ed., 1949. Imported by Grune & Stratton, Inc., New York.

Professor Zimmer has written a book mainly for use of the general practitioner or internist who should make a wider use of fluoroscopy of the chest. A clinical examination of the lungs without fluoros-

copy or films cannot be considered a complete examination. With this in view, the author has furnished a very practical and reliable guide for this field, without giving the impression that fluoroscopy is entirely adequate. He emphasizes its limitations and the limitations of the practitioner.

Enough technical considerations are given to instruct the physician about the danger of unlimited fluoroscopy to the patient and himself. Throughout the volume there are various technical hints, some of which are advantageous to the specialist. By well conceived diagrams, the more common diseases of lungs, heart, and mediastinum are depicted. Unusual and complicated chest diseases are rightly omitted in order not to confuse a non specialist.

For the beginner in chest fluoroscopy, this little book may be of considerable help, and the experienced physician may find in it some practical hints for a more efficient fluoroscopy of the chest organs. The value of films for a more detailed and accurate diagnosis is emphasized. Fluoroscopy should be used for screening purposes and should improve the chest diagnosis of general practitioners and internists considerably.

DIE RONTGENDIAGNOSTIK DER WIRBELSAULE UND IHRE GRUNDLAGEN [Roentgen Diagnosis of the Vertebral Column] By DR. MED. ADOLF LIECHTI, Professor of Radiology and Director of the Roentgen Institute, University of Berne. Second revised and enlarged edition, completed by DR. MED. A. EGGLI. A volume of 364 pages, with 234 illus-

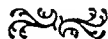
trations. Published by Springer-Verlag, Vienna, 1948.

Unfortunately Professor Liechti died before the second edition of his book on the diagnosis of vertebral lesions could be finished. The work has been completed by Eggl and appears as a volume of 364 pages, of which nearly a hundred are devoted to bibliography. The text is divided into four parts, as follows: (1) Development, (2) Anomalies and Variations of the Human Vertebrae, (3) Diseases of the Vertebrae, (4) Injuries of the Vertebrae.

Parts 1 and 2 reflect the author's great interest in the development and anomalies of the spine. These two chapters are quite complete and will appeal to those whose fundamental interest is in the vertebral column. The remaining two parts of the book are essentially a synopsis or abstract of the literature relating to the various subjects and as such present a great deal of information in a condensed manner.

In the extensive bibliography the author apparently has listed all of the references concerning the subject that were available to him, regardless of whether or not they are referred to in the text. This procedure, frequently used in European literature, will be useful perhaps to those without access to the usual indexes of a medical library.

It is stated that the text is definitely not for the beginner. On the other hand, a specialist will consider the discussion of many subjects too brief for his purpose.



RADIOLOGICAL SOCIETIES SECRETARIES AND MEETING DATES

Editor's Note Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates

UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA *Secretary-Treasurer*, Donald S Childs, M D, 713 E Genesee St., Syracuse 2, N Y

AMERICAN RADIUM SOCIETY *Secretary*, Hugh F Hare, M D, 605 Commonwealth Ave., Boston 15, Mass

AMERICAN ROENTGEN RAY SOCIETY *Secretary*, Harold Dabney Kerr, M D, Iowa City, Iowa

AMERICAN COLLEGE OF RADIOLOGY *Secretary*, William C Stronach, 20 N Wacker Dr., Chicago 6, Ill

SECTION ON RADIOLOGY, A M A *Secretary*, U V Portmann, M D, Cleveland Clinic, Cleveland 6, Ohio

Alabama

ALABAMA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, W D Anderson, M D, 2501 6th St., Tuscaloosa

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY *Secretary*, Fred Hames, M D, Pine Bluff Meets every three months and at meeting of State Medical Society

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY *Secretary* Sydney F Thomas, M D, Palo Alto Clinic, Palo Alto

LOS ANGELES RADIOLOGICAL SOCIETY *Secretary*, Wybren Hiemstra, 1414 S Hope St. Meets monthly second Wednesday County Society Bldg

NORTHERN CALIFORNIA RADIOLOGICAL CLUB *Secretary*, Charles E Grayson M D, Medico-Dental Bldg, Sacramento 14 Meets at dinner last Monday of September, November, January, March and May

PACIFIC ROENTGEN SOCIETY *Secretary*, L Henry Garland, M D, 450 Sutter St., San Francisco 8 Meets annually with State Medical Association

SAN DIEGO ROENTGEN SOCIETY *Secretary*, R. F Niehaus, M D, 1831 Fourth Ave., San Diego Meets first Wednesday of each month

X-RAY STUDY CLUB OF SAN FRANCISCO *Secretary*, Wm F Reynolds, M D, University Hospital, San Francisco 22 Meets monthly on the third Thursday at 7 45 P M, January to June at Lane Hall, Stanford University Hospital, and July to December at San Francisco Hospital

Colorado

COLORADO RADIOLOGICAL SOCIETY *Secretary*, Mark S Donovan, M D, 306 Majestic Bldg., Denver 2 Meets third Friday of each month, at the Colorado School of Medicine and Hospitals

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY *Secretary*, Fred Zaff, M D, 135 Whitney Ave New Haven Meetings bimonthly, second Wednesday

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY *Secretary*, Ellwood W Godfrey, M D, 1676 Boulevard, W Hartford Meets second Friday of October and April

District of Columbia

RADIOLOGICAL SECTION DISTRICT OF COLUMBIA MEDICAL SOCIETY *Secretary*, Alfred A J Den, M D, 1801 K St., N W, Washington 6 Meets third Thursday, January, March, May, and October, at 8 00 P M, in Medical Society Auditorium

Florida

FLORIDA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, F K Hurt, M D, Riverside Hospital, Jacksonville Meets in April and in November

Georgia

ATLANTA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Wm W Bryan, M D, 490 Peachtree St., N E Meets second Friday September to May

GEORGIA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Robert Drane, M D, De Renne Apartments, Savannah Meets in November and at the annual meeting of State Medical Association

Illinois

CHICAGO ROENTGEN SOCIETY *Secretary*, T J Wachowski, M D, 310 Ellis Ave., Wheaton Meets at the Palmer House, second Thursday of October, November January, February, March and April at 8 00 P M

ILLINOIS RADIOLOGICAL SOCIETY *Secretary Treasurer*, William DeHollander, M D, St Johns' Hospital Springfield Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY *Secretary*, Harold L Shinnall, M D, St Joseph's Hospital, Bloomington

Indiana

INDIANA ROENTGEN SOCIETY *Secretary-Treasurer*, William M Loehr, M D, 712 Hume-Mansur Bldg., Indianapolis 4 Annual meeting in May

Iowa

IOWA X-RAY CLUB *Secretary*, Arthur W Erskine, M D, 326 Higley Building, Cedar Rapids Meets during annual session of State Medical Society

Kansas

KANSAS RADIOLOGICAL SOCIETY *Secretary-Treasurer* Anthony F Rossitto, M D, Wichita Hospital Wichita Meets annually with State Medical Society

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Everett L Pirkey, M D, 323 East Chestnut St., Louisville 2

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary Treasurer*, Everett L Pirkey, Louisville General Hospital, Louisville 2 Meets second Friday of each month at Louisville General Hospital

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Johnson R Anderson, M D, No Louisiana Sanitarium, Shreveport Meets with State Medical Society

ORLEANS PARISH RADIOLOGICAL SOCIETY *Secretary*, Joseph V Schlosser, M D, Charity Hospital of Louisiana, New Orleans 13 Meets first Tuesday of each month

SHREVEPORT RADIOLOGICAL CLUB *Secretary*, Oscar O Jones, M D, 2622 Greenwood Road Meets monthly September to May, third Wednesday

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION *Secretary*, J Howard Franz, M D 1127 St Paul St, Baltimore 2

Michigan

DETROIT X-RAY AND RADIUM SOCIETY *Secretary-Treasurer*, George Belanger M D, Harper Hospital, Detroit 1 Meetings first Thursday, October to May, at Wayne County Medical Society club rooms

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS *Secretary Treasurer*, R B MacDuff M D, 220 Genesee Bank Building, Flint 3

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY *Secretary*, C N Borman, M D, 802 Medical Arts Bldg Minneapolis 2 Meets in Spring and Fall

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY *Secretary*, Wm M Kitchen, M D, 1010 Rialto Building Kansas City 6, Mo Meetings last Friday of each month

ST LOUIS SOCIETY OF RADIOLOGISTS *Secretary*, Charles J Nolan M D 737 University Club Bldg Meets on fourth Wednesday, October to May

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Ralph C Moore, M D, Nebraska Methodist Hospital, Omaha 3 Meets third Wednesday of each month at 6 P M in Omaha or Lincoln

New England

NEW ENGLAND ROENTGEN RAY SOCIETY *Secretary-Treasurer*, George Levene, M D, Massachusetts Memorial Hospitals, Boston Meets monthly on third Friday at Boston Medical Library

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY *Secretary-Treasurer* Albert C Johnston, M D Elliot Community Hospital Kcene Meetings quarterly in Concord

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY *Secretary*, Raphael Pomeranz M D, 31 Lincoln Park, Newark 2 Meetings at Atlantic City at time of State Medical Society and midwinter in Newark

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC *Secretary* William J Francis, M D, East Rockaway

BROOKLYN ROENTGEN RAY SOCIETY *Secretary-Treasurer*, J Daversa, M D, 603 Fourth Ave, Brooklyn Meets fourth Tuesday of each month October to April

BUFFALO RADIOLOGICAL SOCIETY *Secretary-Treasurer* Mario C Gian M D, 610 Niagara St, Buffalo 1 Meetings second Monday, October to May

CENTRAL NEW YORK ROENTGEN SOCIETY *Secretary-Treasurer*, Dwight V Needham, M D, 608 E Genesee St, Syracuse 10 Meetings in January May, and October

LONG ISLAND RADIOLOGICAL SOCIETY *Secretary*, Marcus Wiener, M D, 1430 48th St, Brooklyn 19 Meetings fourth Thursday evening, October to May, at 8 45 P M, in Kings County Medical Bldg

NEW YORK ROENTGEN SOCIETY *Secretary* Wm Snow, M D, 941 Park Ave, New York 28

QUEENS ROENTGEN RAY SOCIETY *Secretary*, Jacob E Goldstein, M D, 88-29 163rd St, Jamaica 3 Meets fourth Monday of each month

ROCHESTER ROENTGEN-RAY SOCIETY *Secretary-Treasurer*, Ralph E Alexander, M D 101 Medical Arts Bldg, Rochester 7 Meets at Strong Memorial Hospital, third Monday, September through May

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA *Secretary-Treasurer* James E Hemphill, M D, Professional Bldg, Charlotte 2 Meets in May and October

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY *Secretary*, Charles Heilman, M D, 1338 Second St N, Fargo

Ohio

OHIO STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Carroll Dundon, M D, 2065 Adelbert Road Cleveland 6 Next meeting at annual meeting of the State Medical Association

CENTRAL OHIO RADIOLOGICAL SOCIETY *Secretary*, Paul D Meyer, M D, Grant Hospital, Columbus Meets second Thursday, October, December, February, April, and June, 6 30 P M, Seneca Hotel Columbus

CINCINNATI RADIOLOGICAL SOCIETY *Secretary*, Eugene L Saenger, M D, 735 Doctors Bldg, Cincinnati 2 Meets last Monday, September to May

CLEVELAND RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Merthyn A Thomas M D, 10515 Carnegie Ave, Cleveland 6 Meetings at 6 30 P M on fourth Monday October to April inclusive

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, W E Brown, M D, 21st and Xanthus, Tulsa 4 Meets in October, January, and May

Oregon

OREGON RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Boyd Isenhardt, M D, 214 Medical-Dental Bldg, Portland 5 Meets monthly, on the second Wednesday, at 8 00 P M, in the library of the University of Oregon Medical School

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Sydney J Hawley, M D, 1320 Madison St, Seattle 4 Wash Meets annually in May

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, James M Converse, M D, 416 Pine St, Williamsport 8 Meets annually

PHILADELPHIA ROENTGEN RAY SOCIETY *Secretary*, Arthur Finkelstein M D, Graduate Hospital, Philadelphia Meets first Thursday of each month at 8 00 P M, from October to May, in Thomson Hall, College of Physicians, 21 S 22d St

PITTSBURGH ROENTGEN SOCIETY *Secretary-Treasurer*, R P Meader, M D, 4002 Jenkins Arcade, Pittsburgh 22 Meets second Wednesday of each month at 6 30 P M, October to June

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Maurice D Frazer, M D, Lincoln Clinic Lincoln, Nebr Next meeting in Denver, Colo, Aug 18-20, 1949

South Carolina

SOUTH CAROLINA X-RAY SOCIETY *Secretary-Treasurer*, Robert B Taft M D, 103 Rutledge Ave., Charleston 16

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA *Secretary-Treasurer* Marianne Wallis, M D, 1200 E Fifth Ave, Mitchell Meets during Annual Session of State Medical Society

Tennessee

MEMPHIS ROENTGEN CLUB Meetings second Tuesday of each month at University Center

TENNESSEE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, J Marsh Frère, M D, 707 Walnut St., Chattanooga Meets annually with State Medical Society in April

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB *Secretary* X R Hyde M D, Medical Arts Bldg, Fort Worth 2 Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months

HOUSTON X RAY CLUB *Secretary*, Curtis H Burge, M D, 3020 San Jacinto, Houston 4 Meetings fourth Monday of each month

TEXAS RADIOLOGICAL SOCIETY *Secretary-Treasurer*, R P O'Bannon M D, 650 Fifth Ave, Fort Worth Next meeting Feb 3-4, 1950, in Dallas

Utah

UTAH STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Angus K Wilson, M D, 343 S Main St, Salt Lake City Meets third Wednesday, January, March, May, September, November

Virginia

VIRGINIA RADIOLOGICAL SOCIETY *Secretary*, P B Parsons, M D, Norfolk General Hospital, Norfolk 7

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Homer V Hartzell, M D, 310 Stimson Bldg, Seattle 1 Meetings fourth Monday October through May, at College Club Seattle

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY *Secretary-Treasurer*, Theodore J Pfeffer, M D 839 N Marshall St, Milwaukee 2 Meets monthly on second Monday at the University Club

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY *Secretary*, S R Beatty, M D, 185 Hazel St., Oshkosh Two-day meeting in May, one-day with State Medical Society, September

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE Meets first and third Thursdays 4 P M, September to May, Service Memorial Institute, Madison 6

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA *Secretary*, Jesús Rivera Otero, M D, Box 3542, San-turce, Puerto Rico

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS *Honorary Secretary-Treasurer*, E M Crawford, M D Associate Honorary Secretary-Treasurer, Jean Bouchard M D *Central Office*, 1535 Sherbrooke St, West, Montreal 26, Quebec Meetings in January and June

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES *General Secretary*, Origène Dufresne, M D, Institut du Radium, Montreal Meets third Saturday each month

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA Offices in Hospital Mercedes, Havana Meets monthly

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA, *General Secretary*, Dr Dionisio Pérez Cosío, Marsella 11, México, D F Meetings first Monday of each month

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Diploic Epidermoid and Extra-Dural Pneumatocoele Cranial Defects and Deformity Joseph E J King
Ann Surg 127 925-952, May 1948

This paper consists of two parts which might well be two separate articles since the only thing which diploic epidermoid and extradural pneumatocoele have in common is the fact that they can be easily diagnosed on plain skull films

Diploic epidermoids or cholesteatomas produce irregular defects in the skull bones with scalloped or "geographic" borders but with a characteristic dense line around the outer limit. Some grow outward and cause only thinning of the inner table of the skull but the majority grow inward, destroying the inner table, sometimes occupying huge areas, causing marked displacement of the brain. The bone is not invaded, but the lining membrane must be completely removed or cauterized to prevent recurrence. Growth is very slow.

The differential diagnosis is based on the sharply defined dense white scalloped margin. Neoplastic destruction does not show a dense line at the periphery, while an inflammatory lesion shows reaction but not the sharply defined zone of uniform thickness which is seen in cholesteatoma.

Two successfully treated cases are presented, with excellent reproductions of the films. One of the lesions was nearly 10 cm in diameter and 7.5 cm thick.

The second half of the paper concerns extradural pneumatocoele without perforation of the skull. Pneumatocoele complicating fractures and gunshot wounds is well known but the spontaneous accumulation of air in the extradural space, with the skull intact, as reported here must be very rare.

Two cases are presented. In the first in which operation was performed, the air reached the space between the skull and dura from a small fistulous opening into the middle ear. The patient had had both otitis media and a head injury previously, either of which may have been the cause. The presence of the air resulted in a very bizarre erosion of the skull from within with sharply defined margins and an appearance much like coral rock. Describing the lateral view the author writes "The area is trabeculated throughout denser portions appearing lighter and thinner areas darker. Some areas are almost black. The margins are somewhat scalloped, and the scallops are smaller than those seen in films of epidermoids. They are also more numerous. The margins of the scallops are more distinct at some points and less distinct at others. No point about the margin presents the fuzziness seen in cases of malignancy. The shadow cast by the base of the petrous pyramid is very dense with a small external opening of the auditory canal. The posterior portion of the mastoid shows no cells or else they are lost in the involved area. There is distinct destruction of the posterior portion of the base of the petrus. The part which remains presents a concave surface. The eroded area 'saddle-bags' the petrous ridge and dips into both middle and posterior fossae. In the middle fossa the destructive process involving the squama reaches down to the level of the floor of the sella. In the posterior fossa it extends as far as the base of the skull."

In the anteroposterior view the "dark area" was seen

to extend from high on the cranial vault at a point about 5.2 cm from the mid line, downward into the middle fossa below the petrous pyramid, a distance of 15 cm. There was some destruction of the base of the petrus and this section was not so dense as that of the opposite side. The dark area was more massive above and measured 6 cm in thickness from the inner table of the skull. The remainder of the skull showed quite white by contrast.

This roentgen picture is quite unlike any other. It resembles most closely hemangioma of the skull but is not the same.

A second case resembling the first was subsequently seen and the diagnosis was made on the basis of the similar roentgen picture.

Recognition of the condition before operation is important, so that the fistula may be sought out and closed, as otherwise the air will reaccumulate.

Nineteen roentgenograms, 10 photographs

ZAC F ENDRESS, M D
Pontiac, Mich

Roentgen Changes Produced by Diffuse Torulosis in the Newborn Edward B D Neuhauser and Arthur Tucker
Am J Roentgenol 59 805-814, June 1948

Three cases are reported of torulosis of the newborn. All showed cerebral calcification similar to that reported in toxoplasmosis. Much of the calcification was scattered on the surface in the parasagittal areas, but some was seen deep within the brain substance. In each case the calvarium appeared larger than normal, but with normal bone architecture, although in one case the bones of the base seemed more dense than usual.

Numerous other clinical findings were noted but no other calcification. One case showed enlargement of the liver and spleen and one a pneumonitis with focal atelectasis. Autopsies were obtained in all 3.

Eighteen illustrations, including 9 roentgenograms

ZAC F ENDRESS, M D
Pontiac, Mich

Intracranial Pneumocephalus Report of a Case
David C Straus Arch Surg 56 766-784, June 1948

Intracranial pneumocephalus may be subdural or intracerebral. The former is commonest, but has been reported only after fracture of the frontal sinus. The latter may occur if the dura and arachnoid membrane are torn and the cerebral cortex is broken simultaneously with fracture of the frontal or ethmoid sinus, provided adhesions first form between the brain and dura, walling off a fistulous tract and preventing the air from reaching the subdural space. This same process may also lead to intraventricular collections of air. Subarachnoid collections are seen only in the vicinity of the cisterna magna, as a result of fractures involving the sphenoid or posterior ethmoid cells. Mixed varieties frequently occur. Non-traumatic or spontaneous pneumocephalus follows erosion of the bone between the sinuses and the intracranial surface, usually as a result of infection or tumor.

The two most characteristic symptoms of pneumocephalus are cerebrospinal rhinorrhea and evidence of heightened intracranial pressure. Headache increased by sneezing is an important sign. While a diagnosis can usually be made from the history and clinical symp-

toms, roentgenologic study is the one infallible diagnostic measure. The author does not discuss this phase of the subject, but refers to a paper by Eaglesham (Brit J Radiol 18 335, 1945 Abst in Radiology 47 304, 1946). If there is question as to the presence of cerebrospinal fluid in the nasal discharge, it may be settled by subarachnoid injection of 1 cc of indigo carmine solution into the spinal canal, which stains the cerebrospinal fluid a bluish green.

Treatment may be either operative or non operative. If infection results from the pneumocephalus, it is almost invariably fatal. A case successfully treated without operation is reported in detail.

Eight roentgenograms, 4 photographs

LEWIS G. JACOBS, M D
Oakland, Calif

Skull Roentgenograms of Interest to the Otolaryngologist. Francis H. McGovern, G. Slaughter Fitz-Hugh, and George Cooper, Jr. Ann Otol, Rhin & Laryng 57 387-396, June 1948.

The object of this paper is to review some pathologic conditions and congenital anomalies of the skull and intracranial contents which can be recognized as abnormal by the otolaryngologist in routine roentgenograms of the sinuses. The facts elicited are well known and provoke no discussion. The paper is of value primarily to the man doing occasional x-ray work and without proper opportunities to refer cases to radiologists.

Twenty-two roentgenograms

STEPHEN N. TAGER, M D
Urbana, Ill

Roentgen Examination of the Lingual Tonsil. Solve Welin. Acta radiol 29 546-548, June 30, 1948.

The lingual tonsil consists of a fine fibrous network containing lymphoid tissue scattered over the pharyngeal part of the tongue. It may be involved by acute infectious processes, but chronic inflammation and hypertrophy are more common. In the postero-anterior film small enlargements appear as defects in the contrast medium at the bottom of the vallecula, in the lateral view they are seen as small polypoid tumors between the base of the tongue and the epiglottis. In the case of larger lingual tonsils, the plain lateral film shows a rounded shadow projecting backwards from the base of the tongue, with contrast medium, a lobulated surface is demonstrable in both the postero-anterior and lateral projection.

Lingual goiter and malignant tumors require differentiation. In the former, the usual picture is that of a smooth rounded mass in the pre-epiglottic region with relatively large blood vessels. Occasionally there may be an area of calcific density in the soft-tissue shadow. The hyoid bone may be displaced distally. Irregularity of the rounded shadow is suggestive of a malignant growth, but definite diagnosis should be made only after biopsy.

Five roentgenograms EUGENE R. KUTZ, M D
Baltimore (Md.) City Hospital

Moniliasis of the Larynx. Report of Two Cases. Claude C. Cody. Ann Otol Rhin & Laryng 57 371-376 June 1948.

The importance of the diagnosis of moniliasis of the larynx resides in its differentiation from diseases

with a far higher incidence, such as cancer, tuberculosis, syphilis, and acute simple laryngitis. Two cases of monilial infection of the larynx are here reported. In one, persistent hoarseness, referred pain to the ear, dysphagia, cough, and a tumor on a fixed vocal cord, suggested the possibility of cancer, tuberculosis, or syphilis. The x-ray film of the chest showed bronchovascular mottling of both lungs, suggestive of a monilial infection, but no evidence of tuberculosis or cancer. The sputum examination was negative for *B. tuberculosis*, but showed a profuse amount of *Monilia albicans*. Serologic tests for syphilis were negative. A biopsy showed only inflammatory tissue.

The second patient had an acute laryngitis. The x-ray film was reported to be negative for chronic pulmonary tuberculosis. Sputum examination showed no tubercle bacilli but *Monilia albicans* was present in abundance.

Four illustrations, including 1 roentgenogram

STEPHEN N. TAGER, M D
Urbana, Ill

THE CHEST

Roentgen Studies of Thoracic Tumors. Howard P. Doub. Pennsylvania M J 51 968-975, June 1948.

Roentgen examination is of decisive importance in almost all thoracic tumors. It is useful in determining the location of the tumor, its point of origin, and its character—inflammatory, benign, or malignant.

Tumors of the chest wall may be either benign or malignant. The benign bone tumors are osteochondromas (which are the most common), giant-cell tumors, and osteomas. Their characteristics are the same as in other portions of the body. The benign soft-tissue tumors of the chest wall include fibromas, which usually produce shadows of homogeneous density, the lipomas seen as circumscribed areas of decreased density, and the angomas which may show small areas of calcification similar to phleboliths in other portions of the body. These tumors grow slowly and cause few symptoms unless they become large.

The malignant tumors of the chest wall are the chondrosarcoma, osteochondrosarcoma, fibrosarcoma, myxosarcoma, osteosarcoma, and metastatic lesions. They have a relatively short history. The roentgen signs are those of similar tumors elsewhere, but they may be complicated by pleural and pulmonary involvement with effusion and in some cases, fixation of the lung to the chest wall.

Most of the mediastinal tumors are due either to primary or secondary lymph node involvement. Accurate diagnosis cannot be made from the roentgen examination alone.

Hodgkin's disease usually presents a bilateral shadow, lymphosarcoma unilateral. The tumors usually lie anteriorly and do not pulsate on fluoroscopic examination. They are generally clearly outlined unless secondary lung involvement makes their contours hazy. In many cases superficial nodes are involved and can be removed for study. The blood picture will usually establish the diagnosis in the leukemias. In some cases a clinical test of irradiation therapy will help in making the diagnosis. Lymphosarcoma regresses rather promptly with moderate doses of x-ray.

The benign tumors of the mediastinum are not common. The dermoid cyst can be diagnosed if it contains

teeth or bone. A rounded dense shadow, if it occurs in the posterior mediastinum, is likely to be a ganglioma or neurofibroma. Cystic goiter can usually be identified by its position.

Benign tumors of the lung and bronchi are rare, the chondroma being the most common. This is a well circumscribed slow growing tumor, which may cause symptoms by obstruction of the bronchus. Bronchoscopic examination is of value in making a diagnosis. Cysts may be diagnosed by taking films in various positions to show a fluid level.

Primary carcinoma of the lung is of two main types: the hilar type, originating in the main bronchus or in one of the larger branches; and the lobular type, arising in the periphery of the lung or from the terminal bronchi, and usually appearing as a solitary tumor nodule.

The diagnosis of primary carcinoma must depend upon the history, physical examination, bronchoscopy and roentgen examination. The roentgen signs are varied and are not always pathognomonic. An area of increased density near the hilum, spreading out peripherally and having either a circumscribed border or a fuzzy indefinite outline, is the most common finding. It may be so small as to be easily missed or so large that it constricts the bronchus causing obstructive emphysema or atelectasis. Secondary infection and pneumonitis eventually occur and many times an abscess may form. The parenchymal type of carcinoma shows a more localized area of increased density near the periphery and may involve the chest wall by extension. The superior sulcus tumor (Pancoast tumor) involves the apex and may erode the ribs or dorsal spine.

Primary pulmonary sarcoma is rare and is indistinguishable from carcinoma.

Metastatic carcinomas are generally of two types, nodular and diffuse lymphangitic. Multiple circular shadows with rather fuzzy outlines are suggestive of carcinoma while sarcomatous metastases give more clear cut rounded outlines. The diffuse lymphangitic type of metastasis may simulate a variety of conditions. The roentgen findings consist of an extensive accentuation of the linear markings, usually extending out from the hilum. There may be enlargement of the hilar nodes and, in addition, many small nodules which have somewhat the appearance of miliary nodulation.

The benign pleural tumors in their early stages show a round or oval shadow which is sharply circumscribed and of uniform density. They are slow growing, and may almost fill the chest cavity. Primary malignant tumors of the pleura are unusual. The endothelioma which is the most common, may first appear on roentgen examination as a thickening of the pleura, later fluid develops, rapidly reaccumulating after aspiration. Withdrawal of fluid and the introduction of air may outline the tumor nodules.

The most common tumors of the pleura are metastatic being first manifested by pleural effusion. It is only later that the actual tumor nodules are seen.

Primary tumors of the diaphragm are rare and sometimes the lung must be collapsed in order to determine whether the diaphragm or the lung is involved. Fat pads and cysts make differential diagnosis difficult.

Shadows are sometimes seen in the chest which do not conform to the typical appearance of tumors. A solitary rounded shadow may be produced by a pigmented nevus of the skin which will be disclosed by a simple

chest inspection. Localized erosion of the ribs may be secondary to coarctation of the aorta. Shadows in the mediastinum may be of non-tumorous origin. Cardiospasm may cause an enlargement of the esophagus which will give the appearance of a tumor. In this instance, a history and fluoroscopic study with barium will establish the diagnosis. A diaphragmatic hernia may appear as a tumor, and its diagnosis may also be determined by fluoroscopy with barium. Aneurysms may be diagnosed by fluoroscopic examination, but there are instances in which there is no pulsation present, and the pressure from the aneurysm may cause changes in the lung. Mediastinal lymphadenopathy may be due to tuberculosis rather than tumor.

Single circumscribed areas most often—but not always—represent benign lung tumors. They may also be due to mycotic infection. Miliary nodules of carcinomatosis may simulate miliary tuberculosis, mycotic infection, sarcoidosis, and pneumoconiosis.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Carcinoma of the Trachea. Clarence W. Engler. *Ann. Otol., Rhin. & Laryng.* 17: 429-444, June 1948.

Two cases of carcinoma of the trachea are reported. In the first the tumor was definitely primary in the trachea. In the second the carcinoma was so far advanced when the patient was first observed that it could not be definitely determined, even at autopsy, whether the lesion arose primarily in the trachea or esophagus.

Case I. A man aged 47 years complained of dyspnea, wheezing, incessant tickling in the throat, and continuous coughing for eight weeks. During the last week, the cough had been productive of small amounts of blood and frothy sputum. Fluoroscopic and radiographic examination of the chest showed a sharply circumscribed spherical tumor about 6 cm in diameter in the upper mediastinum, just to the right of and behind the ascending arch of the aorta, lying in intimate relationship with the esophagus which it compressed, and with the trachea at its bifurcation. The lungs appeared clear and well aerated, indicating absence of bronchial obstruction. Tracheoscopy disclosed a large fungating mass extending over the posterior wall of the trachea, at the bifurcation. The tumor bled freely and was quite friable. Histologic examination showed it to be a poorly differentiated squamous carcinoma.

A course of roentgen irradiation was administered in thirty-four days, a total tumor dose of 4300 r being given through six fields, each 6 to 8 cm in diameter with the central ray directed toward the tumor by fluoroscopic localization. Two fields were irradiated daily, with the following factors: 200 kv, 0.5 mm copper filtration, 10 mm copper half-value layer, 70 cm distance. Symptoms were relieved and the tumor disappeared.

A year and nine months later there was a recurrence of coughing and a slight depression of the esophagus in the posterior mediastinal region was demonstrable roentgenographically, but no distinct soft-tissue mass could be identified. Bronchoscopy, however, revealed a mass just below the subglottic space on the anterior wall of the trachea. A fungating tumor was also present at the site of the original lesion. A second course of roentgen treatment was in progress at the time of the report.

The failure to demonstrate the recurrent tumor in this case on routine roentgen examination points to the

necessity of special radiologic methods to reveal lesions of this type. Oblique and lateral views and use of a contrast medium in the esophagus, plus fluoroscopic examinations with the patient changing positions, coughing, and swallowing, may be necessary.

Case II A woman, aged 66, was admitted on June 14, 1947, for a tracheotomy for extreme respiratory distress. Tracheal obstruction presented the passage of the tracheotomy tube, and bronchoscopy revealed a tumor almost totally occluding the trachea. A large portion of the trachea was exposed but the tumor extended too far downward to make its total removal possible. A postero-anterior roentgenogram of the chest showed a pronounced widening of the upper mediastinum. On the lateral view, the esophagus appeared distorted and greatly constricted at the site of the lesion in the trachea. Histologic examination of tumor tissue removed from the trachea showed it to be a partially differentiated squamous-cell carcinoma.

Roentgen therapy was instituted, but the course was steadily downward and death occurred three months after the original examination. Autopsy showed a carcinoma involving the trachea and esophagus.

Most patients with tracheal tumors die as the result of respiratory failure because of obstruction. Any tumor which grows large enough to obstruct the tracheal airway will prove fatal no matter how benign it may be histologically. Since this is so, and since some of the benign tumors apparently are potentially malignant, bronchoscopy is indicated in all patients whose symptoms suggest a tracheal obstruction, for prompt and radical removal of a possible tracheal tumor. In the majority of cases of carcinoma of the trachea, the metastases are only regional. In some reported cases in which the tumors were of high grade malignancy death occurred from respiratory obstruction before metastasis or extratracheal extension had occurred.

Six roentgenograms, 1 photomicrograph

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Carcinoma of the Lung Adrian Lambert. *Am J M Sc* 215: 1-12, January 1948.

The author reports a series of 70 cases of carcinoma of the lung explored surgically for possible removal, comprising 20 per cent of all cases of carcinoma of the lung seen in about seven years. The 25 cases resected represent an operability of only 7.2 per cent. As a result of operative experience, the attitude is tending more and more toward early exploration of cases with only suggestive x-ray findings and with possibly no other evidence of disease. Frequently, exploration was done where biopsy was negative and bronchoscopy was suggestive. The importance of bronchoscopy is paramount as a single diagnostic procedure but the resectability depends on early exploration of cases with suggestive x-ray changes even though bronchoscopic findings are negative. The operability cannot be predicted by bronchoscopy except that surgery is contraindicated in cases where the tumor can be seen to invade the trachea or extend to the opposite side. Age itself was not considered a contraindication to exploration.

Comparison of the symptomatology in those cases which were resectable and in those which were non-resectable was of no help in evaluating the resectability.

If a patient with a carcinoma can stand the loss of pulmonary parenchyma a pneumonectomy is the operation of choice. If the disease is well localized to one

lobe and the hilar nodes are negative lobectomy may be the operation of choice. If thoracoplasty is to be performed, it should be done at an early date, before pleural thickening has developed.

The rate of resectability of adenocarcinoma was high, and was closely associated with negative biopsy. Because the squamous-cell carcinomas were slower growing, the longevity in this group was greatest.

It was felt that irradiation was useless in a large percentage of the patients. It is often impossible to recognize the involvement beyond the lung by x-ray alone.

Seven tables

BENJAMIN COPLEMAN, M.D.
Perth Amboy, N. J.

Myoblastoma of the Bronchus Alvin R. Kraus, Perry J. Melnick, and Joseph A. Weinberg. *J Thoracic Surg* 17: 382-389, June 1948.

Abrikosoff in 1926 described a type of neoplasm which occurs chiefly in immediate relation to striated muscle and which is composed of its embryologic precursors, the myoblasts (Virchows Arch f Path Anat 260: 215, 1926). Many of these tumors have been described in all parts of the body, but only one case has been previously reported in the bronchus.

The authors present in detail a case occurring in a 48-year-old male. His chest symptoms began nine years earlier with pneumonia followed by several bouts of pneumonitis, with subsequent empyema at the right base, for which a rib resection was done. A short time later the right lower lobe was removed for bronchiectasis followed by a fistula. This continued until the patient's last admission, when the right upper and middle lobes were removed. Numerous bronchoscopies were done showing a mass in the right main bronchus. Repeated biopsies were taken with an eventual diagnosis of myoblastoma. The mass after removal measured $6 \times 5 \times 3.5$ cm, it filled and distended the main bronchus breaking through the bronchial wall in one small area. The tumor was benign. Death occurred on the eleventh postoperative day probably from a pulmonary embolism.

There is a brief discussion of the embryology of this tumor as well as a short review of the literature.

Two planigrams, 1 photograph, 1 photomicrograph
HAROLD O. PETERSON, M.D.
University of Minnesota

Significance of Triangular Hilar Shadows in Roentgenograms of Infants and Children Rolfe M. Harvey and Ralph S. Bromer. *Am J Roentgenol* 59: 845-852, June 1948.

A triangular shadow of increased density is seen occasionally in roentgenograms of infants less often in young children projecting from the region of the hilum of the right lung, less frequently from the left. This shadow has a sharp lateral margin which ends in an inferior angle, usually less than 90 degrees and is either in close relation to or merges with the interlobar fissure marking. It is rarely found simultaneously on both sides. The density in the lateral view is located in the anterior mediastinal space.

In a consecutive series of 300 chest examinations in a children's hospital 9 showed these triangular hilar shadows (8 on the right, 1 on the left). Most of them were attributed to enlargement of the thymus. All eventually disappeared and there were no deaths.

Mediastinal pleurisy, pneumonic consolidation of the medial part of the upper lobe, atelectasis and enlarged lymph nodes can also produce this picture

Fourteen roentgenograms

ZAC F ENDRESS M D
Pontiac, Mich

Contribution on the Differential Diagnosis of Multiple Nodular Shadows in the Lungs H G Horst H Legler, and V Buchtala Schweiz med Wchnschr 78 543-545 June 5, 1948 (In German)

The first case reported is that of a 26 year-old man who fell into the water and was rescued unconscious. Sixteen hours after he was admitted to the hospital a chest film showed miliary pulmonary shadows. He made a prompt recovery and a film seventeen days later showed complete clearing of the shadows.

A second patient was an epileptic brought in because of hemoptysis. The initial x-ray examination showed miliary pulmonary shadows, one hour later the patient had a seizure, which was followed by acute pulmonary edema. He gradually recovered and eight days later his chest film was negative.

In both patients the miliary nodulation affected the bases but spared the apices and the nodules varied in size from submiliary to lobular. The appearance was attributed to an acute pulmonary edema and the authors advocate the employment of x-rays for the early diagnosis of "latent" edema of the lungs—i.e., cases of injury or disease of such nature that the presence or development of edema might logically be anticipated.

Two roentgenograms LEWIS G JACOBS M D
Oakland Calif

On Lung Changes in Acute General Dermatitis Nils Frostberg Acta radiol 29 493-502, June 30 1948

Two cases of an acute general exanthema with transitory lung changes are described. The chest films showed a slight discrete pulmonary edema similar to that seen in allergic conditions. The author's conclusions parallel those of workers in this country who claim that the lung may be an allergic "shock organ," just as other tissues.

Six roentgenograms

HARRY J PERLBERG, JR, M D
Baltimore (Md) City Hospital

Functional Pulmonary Changes Following Bronchography William A Zavod Am Rev Tuberc 57 626-631, June 1948

Iodized oil may be retained in the lungs for long periods following bronchography. The study reported in this paper was made to determine if this residual oil caused any impairment in pulmonary function. The investigation was carried out upon 50 unselected patients who had diagnostic bronchograms during their hospitalization. Spirometric studies were performed each day for five days and the bronchogram was obtained on the sixth day. Complete filling of the bronchi to both lungs was done using 20 c.c. of lipiodol. Spirometry was carried out one hour after completion of the bronchography and daily thereafter until the results reached the prebronchogram levels on two successive days. Ninety per cent of the patients showed loss of pulmonary function and decrease in pulmonary volume one hour after bronchography. The highest

average loss was in the reserve air. This loss was recovered gradually and a return to prebronchogram level occurred within a maximum of five days.

Two tables, 2 graphs L W PAUL, M D
University of Wisconsin

Some Observations on the Roentgen Diagnosis of Non-Opaque Foreign Bodies Aspirated into the Bronchi Solve Welin Acta radiol 29 529-535 June 30, 1948

Non opaque foreign bodies in the bronchial tree are often diagnosed on the basis of indirect symptoms and signs, mainly due to valvular obstruction and atelectasis. To increase the certainty of roentgen diagnosis, the author obtains postero anterior and oblique views, after fluoroscopy, using an increase in kilovoltage and time. These will often reveal the foreign body in relief against the air column of the bronchus.

After direct roentgen demonstration of a foreign body, the indication for bronchoscopy is absolute. In other cases the indications are relative. Where the symptomatology suggests the presence of a foreign body and none can be visualized one must think of the possibility of mucosal swelling primary or secondary to an already expelled foreign body or the presence of multiple peripheral foreign bodies.

In cases of atelectasis, the value of being able to determine the site of interruption of the air column is obvious and occasionally the character of the foreign body may be suggested. Tomography has been attempted, but the long exposure time prevents satisfactory results. Several case histories are included.

Six roentgenograms, 1 table

HARRY J PERLBERG JR, M D
Baltimore (Md) City Hospital

Bronchopulmonary Hypogenesis Clinical and Roentgenologic Features in the Adult, with Long Follow-up Observations Louis Schneider Am J M Sc 215 665-670, June 1948

Two cases of bronchopulmonary hypogenesis—i.e., a partially developed bronchopulmonary system on one side and normal lung and bronchi on the other—are reported. The patients were young Negro adults, followed for more than fifteen years. In general, patients with this developmental anomaly show no respiratory difficulty at birth indicating that compensation has occurred during intrauterine development. External symmetry of the chest is well maintained. There is however a tendency to repeated pneumonias and, as the patients grow older, they may complain of exertional dyspnea, bloody sputum or wheezing.

The roentgenogram shows abnormal density of one side of the chest, with displacement of the heart and mediastinum to that side. The bronchogram shows the deviation of the bronchial tree and abnormal branching of the bronchi on the affected side, having a hypogenetic appearance. Some of the bronchi may end blindly. There is no evidence of bronchiectasis.

Six roentgenograms PAUL W ROMAN M D
Baltimore, Md

Diagnosis of Unilateral Total Lung Obscuration of Rare Etiology. A Case of Congenital Left-Sided Pulmonary Atelectasis with Saccular Ectasia of the Large Bronchi. H R Stettbacher Schweiz med Wchnschr 78 586-588, June 19, 1948 (In German)

The report concerns a 68-year-old woman whose chest roentgenogram showed a homogeneous density occupy-

ing the entire left hemithorax. The mediastinum was displaced into the left chest. Possibilities considered in the differential diagnosis included lung or pleural carcinoma, tuberculosis, chronic pneumonia, pleuritis, progressive fibrosis, etc. Bronchiography demonstrated a congenitally hypoplastic left lung occupying the apex of the left thorax only, down to the level of the second rib, with gross saecular bronchiectasis of its bronchi, the middle lobe of the right lung was rotated forward into the left chest and its upper and lower lobes filled the right chest. The heart lay posteriorly in the left paravertebral region. The entire deformity was thought to be due to congenital malformation.

Five roentgenograms LEWIS G JACOBS, M D
Oakland, Calif

Spreading Suppurative Pneumonitis H E Counihan Irish J M Sc, pp 270-272, June 1948

A case of "spreading suppurative pneumonitis" is presented. This case falls into the group of chronic pulmonary sepsis first clearly described by Holmes Sellors in 1946 (Thorax 1 146, 1946). Males of middle age are commonly affected. The onset is not characteristic but relapses and remissions are typical. The symptoms are fever, cough with copious sputum, sweating, prostration, chest pain, dyspnea, and hemoptysis. Physical signs are equivocal but x-ray examination shows consolidation, not segmental, but spreading in a creeping fashion by direct extension, with healing of areas primarily involved. The right lung is commonly affected and spread to the opposite lung is rare.

Chemotherapy is ineffective, and drainage useless. If spontaneous cure does not occur, resection may be tried. The prognosis is poor.

In the case reported here, the diagnoses were successively pneumonia, lung abscess, a malignant neoplasm, and finally "spreading suppurative pneumonitis." The bronchogram was interesting. There was generalized fusiform bronchiectasis with several small intercommunicating cavities with multiple bronchial openings.

Pneumonectomy was advised, but the patient refused surgery. A brain abscess developed and death occurred shortly thereafter.

Two roentgenograms EDWARD E LEVINE, M D
Dearborn, Mich

Delayed Chemical Pneumonitis in Workers Exposed to Beryllium Compounds Harriet L Hardy Am Rev Tuberc 57 547-555 June 1948

Thirty-six cases of pneumonitis apparently due to the inhalation of beryllium compounds are analyzed by the author. The patients had been engaged in the manufacture of fluorescent lamps. In most of the cases, there was a delay in onset of symptoms of from one month to four years from the last date of apparent exposure to the fluorescent powder. The development of the disease was gradual in all cases, most of the patients seeking medical advice because of weight loss and fatigue followed by gradually increasing exertional dyspnea with or without cough. The roentgenograms in the early stages suggested a 'sand storm'. Later there was an increase in hilar shadows and a diffuse reticular pattern on a granular background in the lung fields. Finally, small distinct nodules appeared described as a 'snow storm'. Other features noted in some cases were emphysematous changes at the apices, frequent mid zonal distribution of

the pulmonary densities, and four instances of small but distinct areas of pneumothorax.

The findings on physical examination have not been striking. Oxygen was useful in the treatment of the acutely ill patients. Other treatment was of little value in altering the course of the disease. The cases studied show this illness to be one of long duration. Six of the more severely affected individuals have died. Twenty-three patients are still functionally disabled, 3 are convalescent but well enough to work and 4 are free from symptoms although still showing characteristic roentgenologic changes.

Eight tables

L W PAUL, M D
University of Wisconsin

Pneumoconiosis of Coal-Miners. Parts I and II. C M Fletcher Brit M J 1 1015-1022, May 29, 1948, 1065-1074, June 5, 1948

In extensive surveys of the problem of pneumoconiosis among coal miners in England and Wales, it was found that the amount of dust was the most important factor in the incidence (contradicting an old theory relating the incidence to the hardness of the coal). Mechanization markedly increased the number of cases because the amount of dust was increased. Methods of dust suppression are discussed briefly and the importance of considering whether the men charged with their operation will find them convenient and acceptable, since methods requiring too much trouble will be ignored.

A sociological survey showed that not many disabled miners were able to get satisfactory jobs because of their dyspnea and their lack of training in anything except mining.

The reticular pattern of early cases of silicosis can apparently be produced by pure coal dust (since it was observed in men engaged in loading coal into ships). However, the author has made no chemical analysis of postmortem lungs of this type. If the stage of reticulation is followed by focal emphysema, dyspnea and finally right heart failure occur. Other cases progress to the nodular stage and some go on to massive fibrosis. This latter complication is believed to be dependent upon an adequate silica content of the dust and to be due to the action of some infective agent, which may be tuberculous, although tuberculosis may often pursue an independent course in the presence of reticulation. It appears to develop as commonly in men removed from exposure as in those continuing to work underground.

Therapy consists mainly in prevention. Aluminum therapy is being tried but not much is expected of it. Breathing exercises sometimes help the dyspnea. Yearly mass surveys are recommended to find workers who should be advised to change occupation.

Six roentgenograms ZAC F ENDRESS, M D
Pontiac, Mich

Clearing of X-Ray Shadows in Welders' Siderosis A T Doig and A I G McLaughlin Lancet 1 789-791, May 22, 1948

In 1945, the authors re-examined 15 of the cases of welders' siderosis described by them in 1936 (Lancet 1 771 1936). All except 2 of the men had continued to work full time as welders, and all had remained in good health. One of the 2 had given up welding en-

tirely and the other had become a welding instructor. Of 7 men who showed no specific roentgenographic changes due to dust in 1936, 5 (average age 33.3 years, average welding exposure 14.8 years) still showed no abnormal changes, 1 (aged 35, 16 years welding) was now classed as suspicious, and 1 (aged 30, 15 years welding) showed a slight degree of reticulation. Two welders, classed as suspicious in 1936, showed in 1945 a definite picture of siderosis. Of 6 men who previously showed definite inhalation changes, 5 continued to do so. In 4 of these there was no change in the intensity of the abnormal x-ray shadows. In 1 case there was a considerable clearing of the shadows. The other man had a normal chest film where previously he had shown pronounced roentgenographic changes due to inhalation of dust. The latter 2 cases are reported in detail.

These cases provide evidence that the reticulation and nodulation of welders' siderosis is not necessarily permanent, and that the iron-oxide dust can be eliminated from the lung parenchyma after some years.

Effect of the Use of Calcined Alumina in China Biscuit Placing on the Health of the Workmen. A Field Study in a Group of Pottery Workers in North Staffordshire. A. Meiklejohn and W. W. Jones. *J. Indust. Hyg. & Toxicol.* 20: 160-165, May 1948.

Powdered pure aluminum metal and certain forms of alumina (aluminum hydroxide) diminish the solubility of quartz *in vitro* and in living tissues. This has been demonstrated by numerous investigators, but whether inhalation of these substances is safe and of value in the prevention and treatment of silicosis in man is not yet established.

Until 1929 finely powdered calcined flint was used in the "placing" of chinaware for biscuit firing, and the biscuit placers suffered excessively from silicosis. After it had been proved that calcined alumina was a satisfactory substitute for the flint and that it had no deleterious effect on the health of the workmen, china manufacturers began to adopt alumina as the bedding medium. The particular variety of alumina used is corundum.

In 1946 52 china biscuit placers who had previously been examined and who had many years exposure to flint and thereafter to alumina were still at work in the process. These men were re-examined clinically and a roentgenogram of the chest was taken in each case. In 27, no previous x-ray record was available.

This inquiry revealed that, although these workmen were daily exposed to finely powdered alumina in a greater intensity and over a considerably longer period than is possible with existing methods of aluminum prophylaxis and therapy, not only did new cases of silicosis occur but known cases advanced.

Three tables

X-Ray Diffraction Analysis of Crystalline Dusts. Harold P. Klug, Leroy Alexander, and Elizabeth Kummer. *J. Indust. Hyg. & Toxicol.* 30: 168-171, May 1948.

For the past ten years the standard procedure for the analysis of dusts for quartz has been the x-ray diffraction method developed by Clark and Reynolds (*Ind. & Eng. Chem. Anal. Ed.* 8: 36, 1936). A recent advance in dust analysis is the use of the Geiger-counter x-ray spectrometer. The Geiger counter offers advantages in the determination of the intensities of the

diffraction lines, and better resolution in cases of partial line superposition. It also offers a possibility of avoiding the use of an internal standard in some cases. At present the time required for making an analysis with it is about the same as with the older technique, but it is hoped that this may be shortened. Details of the adaptation of the internal standard technique of Clark and Reynolds to the recording Geiger-counter spectrometer are given. Above 10 per cent quartz the results are usually good to within ± 5 per cent of the absolute amount present. The problem of line superposition is also discussed.

Three tables

Postthoracoplasty Pulmonary Hernia. Report of Four Cases. Irving Pine and Philip Morgenstern. *Am. Rev. Tuberc.* 57: 580-586, June 1948.

Four cases of hernia of the lung following thoracoplasty are reported. All of the patients had pain in the shoulder or axilla. Roentgenograms revealed evidence of the hernia in three of the cases. An area of increased illumination was seen protruding beyond the normal confines of the thoracic cage, accompanied by incomplete or defective regeneration of the ribs. Normal lung markings could be identified, which helped to differentiate the hernias from lung cyst, cavitation or bleb formation. Pulmonary hernia should be considered in the differential diagnosis of any post-thoracoplasty patient in whom persistent intercostal pain or pain in the axilla or shoulder occurs together with a pulsion mass on the chest wall.

Five roentgenograms

L. W. PAUL, M.D.
University of Wisconsin

Bronchiectasis Simulating Chronic Bronchitis. A Study of 46 Cases. J. D. H. Wearing. *Lancet* i: 822-824, May 29, 1948.

In a group of 211 men and 3 women serving in the Army, who had clinical findings suggesting chronic bronchitis, bronchoscopy revealed bronchiectasis in 46 (21 per cent). None of the clinical signs generally attributed to classical bronchiectasis was present.

Only by roentgenography is accurate diagnosis of bronchiectasis possible in the living subject. In certain forms of the disease a plain film is difficult to interpret correctly, but all types are generally obvious when bronchography is used. The present series included 31 cases of cylindrical, 3 of varicose, and 12 of saccular bronchiectasis. The appearances of cylindrical bronchiectasis in the plain film were not sufficiently characteristic for diagnosis in many of the cases.

Pneumonia is thought to play a leading role in the production of bronchiectasis. A past history of pneumonia was given by 56 per cent of the 46 patients with bronchiectasis, and by 32 per cent of the remaining 168 persons without bronchiectasis.

The length of time it takes for a reversible bronchiectasis to become irreversible is discussed. A case is reported in which the bronchi remained dilated for several months and then returned to normal.

Bronchiectasis Following Aspiration of Timothy Grass. Report of Eight Cases. Max G. Carter and Kenneth J. Welch. *New England J. Med.* 238: 832-836, June 10, 1948.

This is a report of 8 cases of bronchiectasis following aspiration of timothy grass. The disease is seasonal.

having its onset in June or in July. The history is suggestive of a foreign body in the lung. Roentgenograms showed a pneumonitis, atelectasis, pneumonia, or lung abscess. In 7 of the cases, the process was on the right side. Bronchoscopy was usually resorted to, and in 3 cases the timothy head was recovered. In 4 cases, no foreign body was found even with multiple bronchoscopies.

One patient recovered completely following bronchoscopic removal of the timothy. In the remaining 7, lobectomy was required because of persistent pneumonitis.

Four illustrations, 1 table

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Histoplasmin and Tuberculin Sensitivity in Relation to Pulmonary Calcifications Among University of Wisconsin Students. Helen A. Dickie and Elizabeth A. Clark. *Ann Int Med* 28: 1087-1093, June 1948.

Five thousand university students were surveyed by photofluorograms and tuberculin testing. Of these, 160 showed pulmonary calcification (or, much less frequently, non-calcified infiltration) with a negative tuberculin test. Of this number 116 were tested with histoplasmin. On further study of the photofluorograms in this latter group, the original diagnosis of calcification was considered unjustifiable in 32. Of the remainder 86 (including 5 with non-calcified infiltrates) were histoplasmin-positive, leaving 18 who reacted neither to tuberculin nor histoplasmin. Fourteen of this group were studied fluoroscopically, and 11 were discarded as without calcification, leaving only 3 who were actually negative to both tests. These results are in good agreement with those of Palmer and others who first studied this subject.

In a second study, comprising several groups of students, pulmonary calcification was found to be two to four times as frequent in histoplasmin reactors as in tuberculin reactors.

Four tables

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Calcification in Twins. Gilbert Houston and W. A. Steiger. *J Pediat* 32: 706-710, June 1948.

Two cases of pulmonary calcification in twins are reported. The first twin showed multiple small areas of calcification in the right lung field. In the second twin a small area of calcification was demonstrable in the left lower lung field. Both children had negative PPD tuberculin tests in dilutions up to 0.005 mg., both had negative coccidioidin skin tests, and both had positive histoplasmin tests of 1+ in 1:100 dilutions.

The symptomatology, physical signs, laboratory findings, pathology, mode of transmission, geographic distribution, and differential diagnosis of histoplasmosis are briefly discussed.

Two roentgenograms. EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital.

Employment of Persons with Pulmonary Tuberculous Lesions. Marion W. Jocz, John J. Prendergast and Carl C. Birkelo. *Occup Med* 5: 496-505, May 1948.

This report describes the application of a planned program for the employment of persons with inactive pulmonary tuberculous lesions. It is based on experience with more than 300,000 examinees of the

Chrysler Corporation during the years 1942 through 1946, inclusive. Specific analyses are presented, dealing with tuberculous persons in the Detroit area. The prevalence of active tuberculosis among the applications for industrial employment was 2.7 per thousand examinees, and of inactive tuberculosis, 7.3 per thousand examinees. The report shows that of each thousand persons with inactive tuberculosis 12.5 will show active lesions during the course of ordinary industrial employment after an interval of 21.8 months.

Fifty-one persons whose initial films were diagnosed as showing no tuberculous signs, but in whom tuberculosis developed subsequently, worked an average of 28.2 months before their lesions were discovered.

The authors conclude that the employment of persons with certain types of inactive pulmonary tuberculous lesions is possible and practicable. The usual conditions of employment in a highly mechanized industry do not constitute a threat to the health of such persons or to their fellow employees.

Six tables

Complications of Arrested Pulmonary Tuberculosis. Abel Froman. *Illinois M J* 93: 306-314, June 1948.

A short discussion is presented of the differential diagnosis of emphysema, bronchiectasis and bronchogenic carcinoma, complicating active or inactive pulmonary tuberculosis. Quite frequently the symptoms caused by the complication are thought to be due to a reactivation of the tuberculosis. Then valuable time is lost in the case of carcinoma or time is needlessly spent in the sanatorium in the case of bronchiectasis or emphysema.

Cases are presented to illustrate the various complications.

Ten roentgenograms, 2 photographs

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Coexisting Pulmonary Coccidioidomycosis and Tuberculosis. Robert S. Study and Philip Morgenstern. *New England J Med* 238: 837-838, June 10, 1948.

A 24-year old Negro was admitted to the hospital in December 1945. A diagnosis of pulmonary tuberculosis having been made at a separation center. A chest film at that time showed infiltration at both apices and in the right third interspace anteriorly. During the war, the patient was on duty in southern California, but was not ill during this period.

On admission, x-ray examination showed minimal infiltration in both apices and an irregular angular shadow above the right clavicle which was found to represent a small thin-walled cavity. Sputum examination and skin tests at this time were negative for tuberculosis and coccidioidomycosis.

The patient left the hospital in March 1946, but returned in June. Films on the second admission were essentially the same as before. Sputum and gastric washings were negative for tubercle bacilli, but on direct smear the sputum was found to contain spherules of *Coccidioides immitis*, and a complement-fixation test was positive. The patient was discharged in February 1947. In October 1947, he was again admitted because of hemoptysis and loss of weight. An x-ray examination at this time showed considerable enlargement of the cavity in the right apex. In addition, the upper third of the left lung was involved by a dense confluent type of

infiltration, with several poorly defined areas of radiolucence. Examination of sputum now showed acid-fast bacilli. Complement fixation tests were strongly positive.

Since World War II, with many service men having had training in the southwestern United States, the possibility of coccidioidal pulmonary infection must be kept in mind. As this case shows, its coexistence with tuberculosis is quite possible.

Three roentgenograms

JOHN B. MCANENY, M D
Johnstown, Penna

Coccidioidomycosis in Veterans of World War II H. E. Bass and A. Schomer. New York State J. Med. 48: 1391-1393, June 15, 1948.

This article is a brief summary of the discussion elicited on the discovery of two cases of coccidioidomycosis in New York City in the Veterans Administration. It typifies the situation which must exist in many places outside known endemic areas of coccidioidomycosis. It also demonstrates that the radiologist must be aware of all possibilities when considering a chronic pulmonary lesion.

In the discussion, the authors bring out that approximately 6,000 members of the Armed Forces acquired this disease in a clinically recognizable form, and they further point out that there were probably a far greater number having a subclinical infection. Reference is made to an article by Fobus and Bestebreurtje (Mil. Surgeon 99: 653, 1946), which is representative of the Army's experience with coccidioidomycosis.

S. F. THOMAS, M D
Palo Alto, Calif

Primary Pulmonary Coccidioidomycosis: Case of Laboratory Infection in England. J. D. N. Nabarro. Lancet 1: 982-984, June 26, 1948.

A case of primary pulmonary coccidioidomycosis in a laboratory worker in England is described. It is thought that the patient probably acquired the infection during manipulation of cultures seven days before the onset of the illness. This is the lower limit of the usually accepted incubation period.

The clinical and pathological features of the disease are reviewed. One roentgenogram is reproduced, showing small irregular patches of consolidation in both lungs.

Pulmonary Moniliasis. R. F. Robertson. Edinburgh M. J. 55: 274-281, May 1948.

A fatal case of pulmonary moniliasis in a woman forty-two years of age is reported. At the age of twenty-one the patient had a severe bronchitis followed by a coryza. Thereafter she was subject to attacks of bronchial asthma, for which she was treated several times in the hospital. X-ray and sputum examinations were essentially negative. Seventeen years after the initial illness the asthmatic attacks had lessened, but cough was worse and there was a copious mucopurulent sputum. Films of the chest showed fibrotic lesions in both upper lobes, with cavitation on the right side. Pulmonary tuberculosis was suspected, but in the course of two years constant observation tubercle bacilli were never found in the sputum though *Monilia albicans* was constantly present.

Three months before her final admission to the hospital, the patient became dyspneic on exertion, with edema of the legs, ascites and a profuse diarrhea. Congestive heart failure secondary to lung disease was suspected, and it was for treatment of this that the patient was hospitalized. Cough and copious mucopurulent sputum with occasional hemoptysis had persisted undiminished. There was no valvular lesion of the heart. A roentgenogram showed diffuse changes involving both lungs, with fibrosis and cavitation in the upper zones, the combined appearance strongly suggesting tuberculosis in a fairly advanced stage. A provisional diagnosis of pulmonary tuberculosis was made. Twelve sputum specimens collected on successive days were negative, on direct examination and guinea-pig inoculation, for tubercle bacilli, but were positive for *Monilia albicans*. Blood culture, production of fixation abscess, serum agglutination, skin test, and therapeutic test were negative or unhelpful in establishing a diagnosis. The patient's condition became steadily worse. A rising blood urea, polyuria, and impaired renal function suggested that uremia was resulting from amyloid contracted kidneys.

At autopsy it was found that the upper and middle lobes of the right lung were almost replaced by several large cavities containing a small amount of fairly thick purulent fluid from which *Monilia albicans* could not be isolated. Similar but less marked changes were found in the left upper lobe. The remainder of the lungs showed congestion, chronic bronchitis and emphysema. There were no signs of tuberculosis on microscopic examination. The presence of amyloidosis was confirmed in the liver, spleen, and kidneys. The final diagnosis was bronchiectasis with amyloid disease.

The difficulties in making a diagnosis of moniliasis are discussed. The author concludes that it is doubtful if primary pulmonary moniliasis really exists. He believes it reasonable to postulate, however, that when secondary invasion of other pulmonary lesions is proved by bronchoscopic methods, *Monilia* may contribute to their chronicity.

No roentgenograms are reproduced.

Q Fever: Case Treated with Streptomycin. Leon Rosove, Harold E. West, and Albert G. Bower. Ann. Int. Med. 28: 1187-1192, June 1948.

The case of Q fever recorded here is the first one to be reported as treated with streptomycin. The patient was severely ill but after forty-eight hours of treatment he began to improve rather rapidly. In twelve days he was discharged symptom free. Previous treatment with sulfadiazine and penicillin had been without effect.

Films reproduced showed consolidation of the left lower lobe with pleural reaction but no fluid. Resolution was rather slow but otherwise the appearance is essentially that of an ordinary lobar pneumonia.

Three roentgenograms. ZAC F. ENDRESS, M D
Pontiac, Mich.

Case of Infectious Mononucleosis with Atypical Pneumonia. Manuel Rodstein. Ann. Int. Med. 28: 1177-1187, June 1948.

A patient of twenty-one had clinical and roentgen findings characteristic of primary atypical pneumonia. Roentgenograms of the lungs revealed progressive changes, through to almost complete resolution, also.

characteristic of the disease The blood findings, on the other hand, were those of an infectious mononucleosis and serologic tests for that disease were positive The author suggests that the virus which caused the infectious mononucleosis produced the lung findings also

[It is becoming more and more apparent that infectious mononucleosis can affect many systems and organs (skin rashes, hepatitis, etc), so that the author's suggestion is a reasonable one Probably many such cases occur and go unrecognized, since the pneumonitis can be present with almost no symptoms and also since infectious mononucleosis is so frequently overlooked]

Four roentgenograms ZAC D ENDRESS, M D
Pontiac, Mich

Mediastinal Emphysema V L Collins M J
Australia 1 614-618 May 15, 1948

Mediastinal emphysema most commonly follows the rupture of pulmonary alveoli into the vascular sheaths of the lung, producing interstitial emphysema which spreads to the mediastinum From there it may pass into the neck, the pleural cavity, or the retroperitoneal tissues Thus subcutaneous emphysema, pneumothorax, or retroperitoneal emphysema may be an accompaniment of mediastinal emphysema

Clinically the patient with mediastinal emphysema exhibits dyspnea and cyanosis The chest movements are slight and the thorax is held in a position near full inspiration Cardiac dullness is obliterated and heart sounds are distant Engorgement of the neck veins and subcutaneous emphysema may be present The diagnosis is established with the aid of a radiological examination In the anteroposterior film there may be little to observe, though a linear shadow of air along either side of the superior part of the mediastinum or the heart borders may give a clue The lateral view is therefore of primary importance Characteristically air is seen just beneath the sternum If the collection of air is large enough, the heart will be displaced posteriorly Air may also be seen in the posterior mediastinum The appearance must not be confused, however with that of tension pneumothorax when air will be seen beneath the sternum because of herniation of the anterior part of the mediastinum In this condition, the anteroposterior view would accurately depict the situation

Treatment depends upon the severity of the symptoms In mild cases simple measures including the administration of oxygen will usually be effective In severe cases or cases accompanied by pneumothorax more drastic measures such as aspiration of the trapped air or insertion of a cannula to allow the air to escape under water, may prove to be life-saving

A case report is included and spontaneous mediastinal emphysema and pneumothorax in the newborn are briefly reviewed

Four roentgenograms
BERNARD S KALAYJIAN M D
Detroit, Mich

Diagnosis of Fallot's Tetralogy and the Rationale of Its Surgical Treatment. Malcolm N Allen M J
Australia 1 729-730 June 12 1948

In infants under twelve months of age the diagnosis of the tetralogy of Fallot is rather difficult since cyanosis may not be noticeable and the roentgen findings may be difficult of interpretation Later cyanosis clubbing of the fingers, polycythemia, and dyspnea become more

prominent, a systolic murmur is heard over the base of the heart, with maximum intensity over the pulmonary area, and the boot shaped cardiac silhouette—due to pulmonary atresia and hypertrophy of the right ventricle—is apparent on the roentgenogram

The tetralogy of Fallot is by far the most common congenital cardiac lesion showing constant cyanosis which is compatible with survival at least to childhood Several conditions, however, must be considered in the differential diagnosis before surgery is attempted The *Eisenmenger complex* is the same lesion without pulmonary stenosis Dyspnea and cyanosis are not so marked and the left cardiac border shows a bulge instead of concavity The lungs are congested instead of showing diminished circulation Obviously surgery is not indicated, since there is no pulmonary stenosis *Transposition of the vessels* rarely permits survival beyond infancy X-ray examination shows a rather characteristic silhouette with a narrow mediastinal shadow and a large globular heart In the presence of a *gross septal defect* the cardiac shadow is of the enlarged spherical mitral type *Pulmonary arteriovenous fistula* is a rare cause of cyanosis and clubbing but in this condition the cardiac findings are negative

Surgical treatment of the tetralogy of Fallot does not effect a cure but does increase the oxygenation of the blood A branch of the aorta or the aorta itself is anastomosed to the pulmonary artery to allow more blood to pass through the pulmonary bed Dyspnea and cyanosis are greatly improved unless irreversible changes have taken place

Two drawings

[The surgical treatment of this anomaly is discussed in detail in two papers following that by Allen (C J Officer Brown Surgical Treatment of Fallot's Tetralogy pp 731-733, R H Orton Anaesthesia in the Surgical Treatment of the Tetralogy of Fallot, pp 733-736]

ZAC F ENDRESS M D
Pontiac, Mich

Value of Roentgenography in the Diagnosing of Cardiac Disorder Following Rheumatic Fever C J Hansson and Erik Jacobsson Acta radiol 29 541-545, June 30 1948

Follow up clinical and roentgen studies were made on 494 children who had suffered one or more attacks of rheumatic fever, to determine the condition of the heart The time of examination was in no case less than four years after the disease's incipency, and averaged 12.2 years The x-ray findings were decisive in the diagnosis in 21.7 per cent of all cases although the clinical-radio logical correlation was frequently inconstant, as is seen by the following table (slightly modified from the original)

Definite organic heart defect	
Clinically and roentgenologically	121 cases
Not clinically but roentgenologically	5 cases
Clinically but not roentgenologically	150 cases
Neither clinically nor roentgenologically	116 cases
Uncertain organic heart defect	
Clinically but with roentgenologic evidence of a defect	42 cases
Clinically but without roentgenologic evidence	60 cases

HARRY J PERLBERG JR M D
Baltimore (Md) City Hospital

Roentgen Diagnosis of Myocardial Infarction L Henry Garland and S F Thomas J A M A 137 762-768, June 26, 1948

The authors reviewed the roentgenkymographic and electrocardiographic records of 249 patients with suspected or known cardiac disorders. Findings were classified as "positive," "negative," or "questionable." The electrocardiograms were made with standard limb and 4F leads and interpreted by experienced cardiologists.

The two methods were in agreement in 201 cases (80.5 per cent). Eight cases had negative kymograms and positive electrocardiograms, 12 positive kymograms and negative electrocardiograms. The authors do not believe that the failure of correlation in these cases can be adequately explained. In 28 cases the findings were questionable with one method and definite with the other. It is felt that a combination of questionable results with one method and positive with the other indicates probable coronary infarct. A combination of questionable and negative is thought to indicate that there is probably no infarct.

Forty-seven of 58 cases of myocardial infarction had positive or probable kymographic findings. In 10 instances kymograms were positive while electrocardiograms were negative. In 5 of the 10 cases the clinical history and findings were typical, so that the diagnosis was not in doubt. The kymograms were decisive in establishing the diagnosis in 5 instances. Four of these cases are presented in some detail.

The method of roentgenkymography is explained, as is the interpretation of kymograms. Localized diminution or absence of pulsation, systolic expansion or paradoxical pulsation, and partial systolic expansion or pronounced diastolic irregularities are considered indications of myocardial infarction.

The authors believe kymography is indicated when the clinical diagnosis is in doubt or when electrocardiographic findings are equivocal or lacking. They also note that the kymogram is often more reliable in designating the severity of an infarct than is the electrocardiogram.

M J SHAPIRO, M D
University of Michigan

Diagnosis of Hypertrophy and Dilatation of the Right Ventricle Mitral Stenosis and Cor Pulmonale E Attinger Schweiz med Wchnschr 78 395-402, May 1, 1948 (In German)

Abnormalities of the right heart are less easily diagnosed than those of the left and may progress even to terminal stages unrecognized. This discussion is pursued under three headings: roentgen findings, electrocardiographic findings, and clinical findings. Only the part dealing with roentgen findings is abstracted.

After a brief review of the roentgen anatomy of the heart, the author states that the direction of the stream of blood entering the right ventricle is toward the left and downward while the exit stream passes almost directly upward. This results in *lengthening* of the right ventricle as the first change due to elevation of the blood pressure in the pulmonary artery. But since the heart cannot elongate a bulging of the pulmonary conus and artery and rotation to the left result, producing the typical 'mitral' configuration. With increase in the hypertrophy and dilatation the next step is a widening of the cardiac shadow which always takes place to the left. Widening to the right is very slight at this stage. The apex appears large and blunt. As enlargement

progresses, the left border of the heart is more and more made up of right ventricle. The hypertension of the lesser circulation produces the roentgen sign of a broadened, sharply outlined, strongly pulsating hilus. In the right anterior oblique projection, the enlargement of the right chambers and the broadening and forward arching of the conus and pulmonary artery stand out, while in the left anterior oblique projection the elongation of the right ventricle and the marked rounding of the anterior border are prominent. The lateral projections show both the last of these findings and an increase in the thickness of the heart shadow.

Roentgen study of the lesser (pulmonary) circulation is necessary to estimate the loading of the right ventricle and the work capacity of the left. Two forms of overfilling of the lesser circulation can be distinguished. The first results from arterial hypertension in this system. Here the overfilling is limited to the arterial trunks, ending at the capillaries. There are found widening of the pulmonary artery and its root, broadening and deepening of the hilus shadow, and widening of the arterial shadows extending into the lung fields. A systolic expansion can be seen, especially in the hilar shadows. Especially important in distinguishing between this and passive congestion is the sharp contrast between the normally or excessively aerated lung and the overfilled vessels, with abnormally sharp demarcation of the vessel shadows. The second condition, passive pulmonary congestion, is a result of pressure elevation in the entire vascular bed of the lesser circulation, both arterial and venous. In this, the overfilling is especially noticeable in the central zones of the lungs. The hilar shadows are enlarged but show expansile pulsation only in very severe cases. If the condition has not progressed to the point of transudation into the alveoli, the lung appears normally aerated, but as edema supervenes, there is a progressive loss of luminosity of the lungs, most marked in the bases. Focal densities then appear, and these may be miliary in character. The appearance of a pleural exudate is also more common in right than in left heart disease. The opposite condition, a reduced filling of the pulmonary circulation, results from pulmonary stenosis or atresia. It is characterized by small hilar and vascular shadows.

Determination of the cause of the right sided enlargement requires study of the left auricle, this is enlarged in mitral lesions and in left heart failure of either infectious or vascular origin. The auricle tends to project beyond the right heart border as it enlarges, but this finding may not be shown by the anterior projection. The right anterior oblique and lateral views will show left auricular enlargement as a posterior projection of the cardiac silhouette into the retrocardiac clear space. Contrast filling of the esophagus aids in demonstrating this since it is also displaced by the enlarged auricle. Study of the right auricle requires the same views as study of the right ventricle. Increase in the shadow of the superior vena cava with an undulatory pulsation of the upper segment of the cardiac shadow is considered typical of enlargement.

Thirteen drawings LEWIS G JACOBS, M D
Oakland, Calif

Aortic Pulmonary Anastomosis in Congenital Pulmonary Stenosis Report of Forty-Five Cases Willis J Potts and Stanley Gibson J A M A 137 343-347, May 22 1948

This article reports 45 cases in which congenital pul-

monary stenosis was treated by anastomosing the aorta directly to a pulmonary artery. This is the procedure originally reported by Potts, Smith, and Gibson (J A M A 132 627, 1946) and made possible by the invention of a clamp which enables the blood to flow through the aorta while the anastomosis is performed.

The operation was undertaken 52 times. In 48 cases the preoperative diagnosis was tetralogy of Fallot. The classic clinical and roentgen findings of this condition are reviewed. Inability to exercise is considered the most important indication for operation. The authors emphasize that variations from the usual picture frequently occur. Failure to hear a murmur is felt to indicate pulmonary atresia rather than pulmonary stenosis. X-ray findings are particularly variable and there may be no roentgen evidence of abnormality. Evidence of gross cardiac enlargement is felt to militate against a diagnosis of tetralogy of Fallot.

The preoperative diagnosis in four patients was tricuspid atresia. In 11 the roentgen findings suggested underdevelopment of the right ventricle and there was electrocardiographic evidence of left axis deviation, which findings made possible the differentiation from tetralogy of Fallot.

The technic of operation is reviewed and slight modifications recently developed are described.

Anastomosis was carried out in 45 patients, with 4 deaths, a mortality of 8.8 per cent. There was only one death among the last 34 patients in whom successful anastomosis was accomplished. Two deaths were due to cerebral thrombosis, one to bleeding into the hypothalamus, and one to postoperative shock and tension pneumothorax in a child with unrecognized apical tuberculosis. Forty-one patients have survived successful anastomosis, 39 are greatly improved, with loss of cyanosis and clubbing of fingers, improved nutrition, and increased exercise tolerance. Two patients, who still become cyanotic on exertion, have benefited moderately by the operation.

Postoperatively the greatest change has been in exercise tolerance. There has been an average increase of 30 per cent in oxygen saturation of arterial blood. In all cases there has been some increase in heart size which appears to stabilize in one to two months. At the time this article was written, only a year had elapsed since the first operation and the authors make it quite clear that evaluation of the total effect of the procedure is not yet possible. They particularly emphasize that the original malformation of the heart and great vessels is still present. Subsequent to surgery, 3 patients had marked cardiac enlargement, and it is feared they will soon go into cardiac failure. It is hoped that cardiac decompensation can be avoided as an early complication by obtaining an anastomotic lumen sufficiently small to obviate excessive strain on the already abnormal heart, while permitting sufficient flow of blood into the pulmonary circuit to relieve cyanosis.

Six patients were explored in whom pulmonary atresia rather than stenosis was found. In these cases the pulmonary artery was non-functioning and the lumen insufficient to permit anastomosis. Three of these children died postoperatively, and in general this group withstood thoracotomy poorly. One instance of Eisenmenger's complex, with adequate flow of blood through the pulmonary circulation, contraindicating anastomosis of the pulmonary artery and aorta, was discovered on exploratory thoracotomy.

Eleven illustrations, including 8 roentgenograms

M J SHAPIRO, M D
University of Michigan

THE DIGESTIVE SYSTEM

Esophageal and Gastric Varices, with Report of a Case. Hugh F Hare, Esther Silveus, and F A Ruoff. S Clin North America 28 729-732, June 1948.

Esophageal and gastric varices are demonstrated only by a combined study utilizing both fluoroscopy and films of the distal esophagus and fundus of the stomach. The patient should be examined upright and supine, with both thick and thin harium. Spot films taken in various projections may demonstrate small areas not visible fluoroscopically.

Esophageal varices must be differentiated from air bubbles, gastric mucosa in small hiatal hernias, tortuous folds (in older patients), mucus curling and beading of the esophagus, and esophagitis. Varices in the fundus of the stomach are to be distinguished from carcinoma and localized gastritis.

The association of esophageal and gastric varices with cirrhosis of the liver has been reported, but little information is available as to the frequency with which they are diagnosed. In 16 cases of cirrhosis coming to autopsy, the authors found varices in 9. Twelve of these patients had been examined fluoroscopically but in only 2 were varices reported, and in one of these they were not present at autopsy. This would indicate that approximately 50 per cent of patients with cirrhosis of the liver have varices at the time of death, but that they can be shown by roentgenography in less than 15 per cent. It may be, however, that a more careful examination would have given a different figure.

Of particular importance is the demonstration of varices in the presence of hematemesis, as it may spare the patient an unnecessary operation. The case of a woman with a history of gastric hemorrhage and a roentgenologically demonstrable filling defect in the fundus of the stomach is reported. The picture was suggestive of tumor, and exploration was undertaken. The patient proved to have cirrhosis of the liver and splenomegaly. Varices along the greater and lesser curvatures were responsible for the filling defect.

Five roentgenograms

G REGNIER, M D
University of Arkansas

Thoracic Stomach Produced by Esophageal Hiatal Hernia and Congenital Short Esophagus. F Johnson Putney. Ann Int Med 28 1094-1105, June 1948.

This is a rather rambling article in which practically all types of diaphragmatic hernias of the stomach are touched upon. Nothing that is new is presented. Radiologists will not agree with the statement that esophagoscopy is needed along with fluoroscopy and films to make the diagnosis.

One case of congenitally short esophagus with thoracic stomach in an eight-year-old boy is illustrated. A case in a man of seventy two with radiographic findings suggesting a congenitally short esophagus is also presented but this was believed actually to be a hiatal hernia of long duration. In both these cases there was stenosis at the esophagogastric junction which caused difficulty in swallowing. Several other cases are briefly presented.

Five roentgenograms

ZAC F ENDRESS, M D
Pontiac, Mich

Diagnosis of Gastric Disease Should Radiology of the Stomach Be Abandoned? V J Kinsella M J Australia 1 609-614, May 15 1948

The thesis of this author is the deplorable inaccuracy and inadequacy of radiological examination of the stomach as performed in Australia. He describes the usual routine as simply fluoroscopy and the taking of one or two roentgenograms with the patient erect. If his statements can be taken at face value, there is reason for his indictment.

The author believes that the clinician should be very thorough in his study of the patient's symptoms and signs. He should also be thoroughly familiar with radiologic procedures in the study of the stomach including the appearance of the organ radiographically in all positions. He should look upon the radiologist as a valued assistant, but no more than an assistant in the search for a diagnosis. He should instruct the radiologist in the manner in which additional studies are to be made when the preliminary radiologic diagnosis is not in accord with the clinical impression.

Cases from the author's own experience and that of others are cited in which the diagnosis by the radiologist was repeatedly in error. In some instances as many as six examinations were made over a period of years before a correct diagnosis was made. In almost every instance, the situation was hopeless by that time. Review of many of the earlier examinations indicated that the diagnosis should have been obvious on the first or second radiological examination in most instances. Examination should be done in the prone, supine, Trendelenburg and other positions with rotation of the patient from side to side and the use of pressure filming to bring out details.

The author states that many of the inadequate and inaccurate examinations were done by senior, not junior specialists in radiology. He believes that this can only imply need for much closer co-operation between radiologists and clinicians for the benefit of the patient.

[To those who desire the candid opinion of others of radiological efforts this article is indeed worth reading in its entirety. Though it may not apply directly to American radiologists its criticism of super-speed inadequate and inaccurate examinations is evidence that radiologists are not held in the highest esteem in some quarters. There is much of merit in articles of this type if they do nothing more than stimulate radiologists to carry out their examinations so thoroughly as to eliminate all possible sources of error and to correlate their findings with those of the clinician, the pathologist, and the surgeon for greater accuracy in the early diagnosis of gastric lesions.—B S K.]

Eighteen roentgenograms

BERNARD S KALAYJIAN, M D
Detroit, Mich

Effect of Tetraethylammonium Chloride on Gastric Motility in Man Donald C Dodds Carlton L Ould and Morris E Dailey Gastroenterology 10 1007-1009, June 1948

Tetraethylammonium chloride is structurally similar to acetylcholine. The major action of this agent is to block transmission of both sympathetic and parasympathetic impulses at the autonomic ganglia. To determine the effects of the drug on gastric motility the authors studied fluoroscopically 20 apparently healthy men between the ages of twenty-one and fifty-five.

The vigor of the peristaltic activity of the stomach was recorded and a plain film of the abdomen was made three hours after administration of barium. Subsequently the men were given 0.3 or 0.5 gm of tetraethylammonium chloride, as a 10 per cent solution, and the study was repeated. The effects on gastric and intestinal movement and tone were noted and three-hour films were taken to demonstrate any gastric retention and any alterations in the passage of the barium through the bowel.

In all subjects peristalsis disappeared from the stomach and small bowel in an average of three minutes following injection, and the stomach appeared as a large atonic bag. Peristalsis remained absent on an average of forty-five minutes, but in some subjects it was not restored in one and a half hours. Movement returned sooner in the small bowel than in the stomach and the three-four film showed no change from the control study in the speed with which barium traversed the bowel. There was a significant delay in gastric emptying nearly half the group showing 25 to 70 per cent three-hour retention.

In the discussion, the authors point out that the appearance of the stomach after administration of tetraethylammonium chloride is strikingly similar to that after vagotomy. They feel that use of the drug as a safe non-surgical method of blocking the vagal effects on the stomach deserves thorough evaluation.

S F THOMAS, M D
Palo Alto, Calif

Partial Gastrectomy The Clinical, Gastroscopic, and Radiological Considerations Moses Paulson and Eugene S Glad-den Gastroenterology 10 970-977, June 1948

Clinical gastroscopic, and radiologic studies were made in a series of 25 unselected cases in which subtotal gastric resection had been done. The patients covered a wide age range and the interval between operation and examination was from nine days to five years. The x-ray examination was reported as normal in all but 3 cases. One of the early cases ("1" examined prior to the twenty-first postoperative day) showed some retention of barium in the residual stomach at twenty-four hours and another showed a slightly dilated distal jejunal loop. Of the cases examined later than the twenty-first day, only one showed any roentgenologic abnormality namely a constriction about the stomach resulting in delay in initial emptying but not after five hours.

The alterations observed through the gastroscope shortly after operation were usually localized about the stomach consisting of edema with or without erythema. In contrast the later changes tended to be more diffuse with thickening, erythema, friability and occasionally edema. The latter changes were variable, reversible even to normal but recurrent.

In neither the earlier nor the later group was there any consistent relationship between the gastro-intestinal complaints and objective findings.

Three illustrations, 1 table

Roentgen Diagnosis of Cancer of the Cardiac Region of the Stomach Robert S Sherman Surgery 23 874-883 June 1948

In a contribution to a symposium on cancer of the esophagus and cardia of the stomach, chiefly of surgical

interest, Sherman presents an excellent review of the anatomy of the cardiac region, the technic of its examination, the difficulties of diagnosis, and the things for which the radiologist should look. While he presents nothing new, he has left very little out. There are some who will disagree with accepting the healing of an ulcerative lesion as proof of its benignity, but that is a matter of judgment.

A series of 25 cases seen and operated upon at Memorial Hospital is analyzed to determine the accuracy of the roentgen findings. Close correlation with the gross pathology was found in practically all respects.

Unusual tumors in this area are also discussed, as well as the appearance following surgical removal and anastomosis.

ZAC F. ENDRESS, M.D.
Pontiac, Mich

Habitual Prepyloric Spasm. Martin L. Tracey
S Clin North America 28 777-783, June 1948

A discussion of chronic, persistent, long-standing prepyloric spasm and its differentiation from organic lesions in the prepyloric area is presented. The diagnostic procedures consist of (1) repeated roentgenographic studies, (2) gastroscopy, and (3) therapeutic trials. After the spasm has been at least temporarily diagnosed, repeated x-ray examinations should be carried out in all possible positions, particularly with the patient supine and turned up toward the left side, the right side facing the fluoroscopic screen, thus giving an air-contrast effect. Gastroscopy has been disappointing because of the difficult angle from which the area to be examined must often be viewed. A positive gastroscopic study is helpful but negative findings do not exclude a lesion.

In the absence of an ulcer niche or any evidence of neoplasm, the author gives his patients a therapeutic trial consisting of bed rest and ulcer management in the hospital. If this is followed by complete freedom from distress, absence or disappearance of occult blood from all stools and complete resolution of the defect, one can feel that the spasm was functional or benign.

Seven cases are discussed in which exploratory laparotomy was performed when other diagnostic efforts had not given an accurate diagnosis.

Two roentgenograms. JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Case of Benign Myoma in the Stomach. O. W. Husebye. Acta radiol 29 525-528, June 30 1948.

The author describes a case of myoma of the stomach, of unusual size and with irregular calcifications. The tumor filled the entire fundus and corpus of the stomach. Under fluoroscopy a duodenal sound was introduced and with a syringe small quantities of air were blown into the stomach. The air ascended between the tumor and the stomach wall, isolating the tumor, and outlining its smooth, regular surface and small pedicle. A subtotal gastrectomy was performed and the diagnosis was made histologically.

Four roentgenograms, 1 photograph.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Prolapse of the Gastric Mucosa. Report of Six Cases. Ira A. Ferguson. Ann Surg 127 879-886, May 1948.

A review of the literature on the subject of prolapse of the gastric mucosa shows that relatively little has been

written upon the subject. The condition is apparently secondary to a hypertrophic gastritis, the redundant mucosa finally being forced by peristalsis through the pylorus. Typical cases show a duodenal cap which is markedly concave at the base and rugal markings can be seen in the concavity.

Few cases have so far come to surgery, probably because the condition responds rather readily to medical treatment. Symptoms are those of a peptic ulcer, but not always typical.

The author presents 6 cases, in only one of which was operation done. A film of the operated case is reproduced, showing the typical findings.

Two illustrations. ZAC F. ENDRESS, M.D.
Pontiac, Mich

Jejuno-Gastric Intussusception. A Rare Complication of the Operated Stomach. Sten Aleman. Acta radiol 29 383-395, May 31, 1948.

The author has reviewed some 70 reported cases of jejuno-gastric intussusception following operation upon the stomach, of which 12 were diagnosed by x-ray. Clinically the cases are divided into acute and chronic. The acute cases are characterized by extreme nausea and vomiting (first food, then bile, and finally blood) combined with intermittent colicky epigastric pain at the onset. The general condition is at first unaffected, as evidenced by a normal pulse and temperature, however, the pulse gradually rises. There may be some swelling and tenderness to the left of the epigastrium. When first seen, these patients are usually referred for roentgen study with a presumptive diagnosis of a paralytic ileus or a bleeding ulcer, and routine films which may be taken show nothing of significance. The author advises the use of a small amount of barium with compression for the examination of these cases and describes the following typical picture. The greater curvature of the stomach is convex cranially and the pyloric segment is displaced to the right. Neither is the gastro-enterostomy stoma seen nor is the evacuation of barium through it visualized. A striated filling defect in the form of an oval or sausage-shaped shadow protruding from the gastro-enterostomy stoma is pathognomonic. Across it are narrow streaks of contrast medium a few millimeters apart. With a small intussusception these lie concentrically around a perpendicular axis. When enlarged these streaks assume a band-like distribution. The streaks are due to a collection of barium between the Kerkring folds. The gastric mucosa is displaced cephalad and when the patient is in the erect position, the barium sediment lies inferiorly in the stomach and the intussusception may float on the surface like a wire spiral.

The chronic case is less characteristic and the usual complaints center around a periodically recurrent discomfort. There is usually a sense of fullness in the epigastrium, with less vomiting than in the acute case and no hematemesis. Cramp-like epigastric pains may occur but not necessarily. The discomfort is usually associated with meals and disappears an hour or so thereafter. There is no absolute obstruction in this group, and spontaneous reduction often occurs.

Three types of invagination occur: intussusception of the afferent loop (invaginatio descendens), intussusception of the efferent loop (invaginatio ascendens), accounting for 43 of 58 cases in which the type of invagination was indicated, a combined type with intussusception of both loops. From a roentgenologic point of

view, only those cases are of interest in which the apex of the intussusceptum lies within the stomach, making it theoretically possible to obtain the typical striated filling defect. These constitute about 85 per cent of the cases.

A case is reported in which a jejuno gastric intussusception occurring some twenty years after a Billroth II stomach resection was diagnosed roentgenographically. The history would indicate that a similar intussusception six years earlier was spontaneously reduced.

Ten illustrations, including 8 roentgenograms

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

A Case of Chronic, Non-Specific Jejunitis and Stenosis O. W. Husebye. *Acta radiol.* 29: 516-520, June 30, 1948.

The most difficult portion of the digestive tract to examine roentgenographically is the small intestine. The author reports a case of chronic inflammation of the jejunum in which the survey film revealed gas-filled intestinal loops with greatly thickened walls. The patient was then given a barium meal and the contours of the jejunum were noted. Its outline was irregular and there were defects in the contrast medium. Strictures were also demonstrable, and the barium was delayed in its passage. Cancer was suspected. At operation the stomach was found to be surrounded by adhesions and there were numerous areas of dilatation and stenosis in the jejunum, from the duodenojejunal junction to the ileum. The mucosa appeared to be chiefly affected, with the muscularis and serosa being secondarily involved. One portion of the bowel approximately one yard in length showed the serosa to be affected. Postmortem examination revealed about the same findings that were seen on operation. The histologic diagnosis was subacute chronic ulcerative inflammation.

Five illustrations, including 2 roentgenograms

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital

Diagnostic Case Study [Gallstone Ileus] E. W. Minty, O. L. McHaffie, and A. H. Wells. *Minnesota Med.* 31: 656-659, June 1948.

This paper comes from a Clinico Pathological Conference. The case reported is that of a woman of 63 years with a history of gallstone colic followed many years later by a sudden attack of intestinal obstruction with fecal vomiting and typical roentgen findings. At necropsy a gallstone was found wedged in the ileum, the wall of which it had perforated. There was a healed cholecystoduodenal fistula.

Gallstone ileus is one of the late and serious complications of cholelithiasis, carrying a mortality of 40 to 50 per cent. It is invariably preceded by some type of cholecysto-enteric fistula but, while such fistulas are fairly common, gallstone ileus accounts for only about 2 per cent of all cases of small bowel obstruction. Once the condition is suspected, it can be definitely diagnosed by roentgen examination. Finding of air in the bile ducts, as a result of the fistula, is the usual basis for diagnosis. Sometimes the bile ducts fill with barium, when the latter is given by mouth but this can also occur with a large patent ampulla of Vater. At times an opaque stone is demonstrable in the small bowel, with proximal distention. During a barium enema the

barium may flow into the terminal ileum and demonstrate the stone. Thorium chloride in dilute solution has been given by mouth and in three or four hours it may outline the calculus. Apparently this does no harm and is not contraindicated, as is barium by mouth, in cases of bowel obstruction.

As early diagnosis is imperative for the proper treatment of this condition, it should be considered a possibility in every elderly individual with a history of partial or complete bowel obstruction.

One roentgenogram, 1 photograph

WILLIAM H. SMITH, M.D.
University of Louisville

Intestinal Intubation in Small Bowel Distention and Obstruction. Further Experiences with the Single Lumen Mercury Weighted Tube and Analysis of Complications. Franklin I. Harris and Milton Gordon. *Surg., Gynec. & Obst.* 86: 647-658, June 1948.

As a result of their experience with the single lumen mercury weighted tube for intestinal intubation (see Harris, *Surg., Gynec. & Obst.* 81: 671, 1945), the authors advocate certain changes in the structure of the tube and in the technique of its introduction. One restriction upon which they now insist is that progress of the tube downward be stopped at the 3 foot mark until an x-ray film has been taken. As previously emphasized, frequent flat films of the abdomen must be taken and the duration of intubation is determined by roentgenological as well as clinical improvement.

Twenty-four roentgenograms illustrate the use of the tube and some of the attending complications.

Enterogenous Cysts of the Duodenum. Report of a Case That Is Unusual If Not Unique. W. Lowndes Peple. *Ann. Surg.* 127: 912-916, May 1948.

Enterogenous cysts of the duodenum are of rare occurrence. They are said to represent fetal inclusions. The author found 14 cases in the literature, the oldest patient being fifteen years of age. His own case is unusual in that symptoms developed at the age of sixty-nine and roentgenograms made twenty-three years earlier showed a normal duodenum. The cyst was found just beyond the pylorus and had caused partial obstruction. The author is at a loss to know why if the cyst was congenital, it was silent so many years and what the factor was that activated its growth.

Four illustrations, including 1 roentgenogram

[For still another case of this unusual condition see Lorber and Machella, *Gastroenterology* 10: 892, 1948. *Abst. in Radiology* 52: 605, 1949.—Ed.]

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Familial Polyposis and Carcinoma of the Colon. William L. Estes, Jr. *Ann. Surg.* 127: 1035-1045, May 1948.

Polyposis of the colon occurs in the following main forms: (1) single or multiple polyps developing chiefly in adults as simple neoplasms of the mucosa with no known cause or following chronic inflammatory disease of the colon, as ulcerative colitis, (2) diffuse multiple polyposis, seen in childhood or early adulthood. The diffuse type usually has a marked hereditary and familial background with a strong tendency to malignant change at an early age.

The author presents the history of a woman and her seven children. Her father had died at forty years of age, cause unknown. She herself died of peritoneal carcinomatosis following resection of the sigmoid for a constricting adenocarcinoma. Multiple polyps were present in the colon. One of the children died in infancy. Of the remaining 6, all have either died of carcinoma of the sigmoid superimposed upon multiple polyposis or have been shown to have multiple polyposis of the colon or rectum with or without carcinoma.

Such a history as this makes clear the importance of thorough investigation of all members of a family in which diffuse polyposis of the colon has been found. The fact that three of this family who were completely symptom free were found on examination to have well established polyposis indicates the fallacy of dependence upon history or symptoms alone for the diagnosis. This may be established by rectal examination, sigmoidoscopy, and double-contrast (barium-air) enema studies.

The treatment of choice seems to be colectomy with preservation of the rectum if it is not invaded by carcinoma. A low ileosigmoidostomy is done and, as polyps appear in the rectum, they are fulgurated.

Five illustrations, including 2 roentgenograms

ZAC F ENDRESS M D
Pontiac, Mich

Mucosal Studies in Colitis Due to Parasites Julian Arendt and Jack Coheen. *Am J Roentgenol* 59 865-876, June 1948

The authors stress the importance of the mucosal relief pattern as seen on the evacuation film as an aid in the diagnosis of parasitic infestations of the colon. They report such a study in 32 cases. In a high percentage of these, mucosal changes, such as spider-like widening and derangement of folds were found in typical locations, particularly in the cecum, ascending colon, and sigmoid. In combination with the mucosal changes, increased spasticity was observed in these areas, sometimes with the characteristic cecal deformity described by Bell (*Radiology* 32 332, 1939). Not only severe but also milder types of *Endamoeba histolytica* infections (amebiasis proper) and one case each of *Diandamoeba fragilis* and *Monilia* infestation showed deviations from normal.

Changes in the cecal area and lower ascending colon combined (in a ratio of 2 to 1) with deviations from normal in the sigmoid are strongly suggestive of protozoan infestation, while continuous involvement of the colon ascending from the rectum and sigmoid suggests ulcerative colitis. The character of the ulcers is another distinguishing feature. The ulcers of amebiasis have been designated by the descriptive terms 'button-hole ulcers,' 'sea-anemone ulcers,' and 'seaweed sloughs.' Their demonstration in the cecum is barely possible with the contrast media at present available. In distinction from ulcerative colitis, the mucous membrane between the ulcers is preserved. The coexistence of ulcerative colitis and amebic colitis is diagnosed from the roentgen appearance of continuous involvement of the colon and demonstration of *Endamoeba histolytica* in the stools.

A number of excellent examples of the various mucosal patterns are reproduced. This article should be seen in the original by everyone doing barium studies.

Sixteen roentgenograms, 1 table

ZAC F ENDRESS M D
Pontiac, Mich

Ulcerating Carcinoma of the Sigmoid Report of a Case with an Unusual Roentgen Picture Maurice Feldman, Mark E Gann, and Tobias Weinberg. *Gastroenterology* 10 1018-1021, June 1948

This is an interesting case report of an ulcerating carcinoma of the sigmoid, which produced little narrowing or change in the contour of the lumen but was demonstrable in a barium enema study as a pseudo polypoid filling defect in the barium column. The case is otherwise not unusual but for the fact that the carcinoma was not of the common annular type but ran longitudinally with the long axis of the sigmoid colon.

Three roentgenograms, 1 photograph

S F THOMAS, M D
Palo Alto, Calif

Volvulus of the Sigmoid Colon Victor D Woronov, Bernard S Epstein, and Henry W Louria. *New York State J Med* 48 1364-1367, June 15, 1948

The authors believe that two guiding factors might serve to reduce the high mortality in volvulus of the sigmoid (40 to 46 per cent), namely, early diagnosis and conservatism in treatment. They report 6 cases in detail, with fair illustrations. The method, which they followed was suggested in 1941 by Holmgren (*Acta radiol* 22 404, 1941), who was successful in reducing a volvulus under fluoroscopic control with the use of a long enema tube.

The authors do not imply that this is permanent treatment of volvulus, since recurrences take place in about 20 per cent of the cases, but consider it useful for acute or subacute volvulus until the patient can be brought into complete control with proper preparation and adequate preoperative measures.

S F THOMAS M D
Palo Alto Calif

Meckel's Diverticulum. Jerry W McRoberts. *Arch Surg* 56 718-722, June 1948

A general discussion with mention of 8 cases seen by the author in his practice. Three cases are reported in some detail. Special mention is given the complications of bleeding and obstruction due to a congenital band attached to the tip of the diverticulum. The other 5 cases were found accidentally at laparotomy.

LEWIS G JACOBS, M D
Oakland, Calif

Temporary Failure of Gallbladder Visualization by Cholecystography in Acute Pancreatitis H L Silvani and H J McCorkle. *Ann Surg* 127 1207-1211, June 1948

In a group of 28 patients cholecystograms were made during the acute phase of pancreatitis with iodekon administered intravenously. The gallbladder was visualized normally in only 12 patients. In 6 of the remaining 16, cholecystography after subsidence of the acute phase of the pancreatitis gave normal visualization. Five others in the group were operated upon and found to have a normal gallbladder, in 5 no follow-up was obtained.

Apparently in some patients with pancreatitis the ability of the normal gallbladder to concentrate iodekon was lost temporarily during the acute phase of the illness. No evidence of impaired hepatic function was found in those cases in which liver function tests were done, and none of the patients was jaundiced. Ex

planation of temporary failure of visualization is not apparent

Six illustrations, including 3 roentgenograms, and 1 table

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

Intrathoracic Extension of Hepatic Tumors Herbert D. Adams, S. Clin. North America 28: 679-683, June 1948

Two cases of hepatic tumor with extension into the thorax are recorded. In both cases the symptoms were primarily of thoracic origin. In the first case roentgenograms of the chest were reported as showing "clouding of the left base with an apparent soft-tissue mass just above the diaphragm which produces a depression on the air bubble of the fundus of the stomach indicating that the mass was fairly firm." The left diaphragm was elevated. The interpretation was "tumor of the left lung, probably malignant." Bronchoscopy revealed atelectasis of the left lower lobe from extrinsic pressure on the bronchus with no visible tumor. Exploratory thoracotomy revealed a dense, hard mass involving the left lower lobe, lingula, left diaphragm, and left lobe of the liver, which were resected. The pathologist diagnosed hepatoma arising from the left lobe of the liver.

One radiographic finding in this case is of significance in establishing the primary site of the lesion—the impression on the gastric air bubble by a soft-tissue mass. This is sometimes a finding in subdiaphragmatic abscess involving the left lobe of the liver, and in this case indicates that the primary tumor was beneath the diaphragm.

In the second case bronchoscopy was essentially negative. Roentgenograms showed a rounded mass of soft-tissue density in the anterior portion of the right chest, which appeared to be continuous with the diaphragm. The findings suggested either a hernia through the foramen of Morgagni or a pleural cyst. At operation there was found a localized eventration of the diaphragm with a rounded mass of normal liver protruding into the thoracic cavity, covered by a thin layer of atrophic diaphragm. This defect was repaired and the patient recovered. The symptoms were apparently due to a minimal bronchiectasis.

Three roentgenograms are reproduced but do not show all points mentioned in the text, due to losses in reproduction.

G. REGNIER, M.D.
University of Arkansas

Cholangiography Magnus I. Smedal and C. Franklin Sornberger, S. Clin. North America 28: 605-611, June 1948

In the Lahey Clinic visualization of the biliary tract by means of opaque media is reserved primarily for those cases in which a plastic operation or a repair of a common duct has been performed or when the common duct has been opened and a T-tube left in it. In rare instances in which anomalies of the common duct have been encountered at operation subsequent cholangiography may be of value to determine function. Diodrast is the medium employed and only occasionally is it injected under fluoroscopic control. The syringe method is used and at the slightest evidence of resistance the injection is discontinued and radiography begun.

The routine films are a plain film before injection, an anteroposterior stereoscopic and a right lateral film

of the right upper quadrant immediately after injection, a single anteroposterior and occasionally a right lateral film at fifteen to thirty minutes. The T-tube remains clamped until the last film has been taken.

Thirteen roentgenograms

CHALMERS S. POOL, M.D.
University of Arkansas

Clinical Evaluation of Cholangiograms Hart Hagin and H. L. Townsend, Ann. Surg. 127: 810-815, May 1948

Whenever a drainage tube is placed in the common duct or a biliary fistula exists, cholangiography can be done. If calculi are found the cholangiogram should be made before the tube is removed and the patient dismissed. In an occasional case it will reveal a stone left behind during common duct exploration. By the use of a portable Bucky diaphragm it is possible to obtain good films in the operating room at the time of surgery, the so-called "immediate" cholangiogram. This is undoubtedly the procedure of choice and, if adopted as a routine, should save many secondary operations. The technique is described.

The authors list the indications for cholangiography as follows:

(1) In common duct drainage and biliary fistula, delayed cholangiography is used in all cases to determine the presence of stones or other pathologic conditions and to observe the return of the common duct to normal size and function.

(2) In acute cholecystitis, if cholecystectomy is performed, an "immediate" cholangiogram can be obtained by injecting the opaque medium through the cystic duct. If only a cholecystostomy is performed, there is no practicable advantage accomplished by an "immediate" cholangiogram, but a delayed cholangiogram, obtained by injecting an opaque medium through the drainage tube after free drainage has been established, will often give invaluable information.

(3) In cases of elective operations for chronic cholecystitis and cholelithiasis, the "immediate" cholangiogram can be used routinely without great difficulty or loss of time by injecting the opaque medium through the cystic duct, the gallbladder or the common duct.

(4) In anomalies of the ductal system encountered at operation, an "immediate" cholangiogram obtained by injecting the opaque medium through the cystic duct or gallbladder, should be used and will give the surgeon assurance and comfort by furnishing immediate visual demonstration of the ductal system.

Mention is made of the difficulty of obviating respiratory movement during the rather long exposures necessary, but one wonders why the anesthetist could not hold the patient's nose and mouth closed for that time.

Seven roentgenograms, 1 drawing

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Hiatus Hernia, Diverticula and Gall Stones. Saint's Triad. C. J. B. Muller, South African M. J. 22: 376-382, June 12, 1948

The author was unable to find any reference in the literature to the association of hiatus hernia, diverticula of the colon and gallstones. His attention was first called to this triad by Professor Saint of Cape Town (whence the designation Saint's triad) and he has him-

self seen 3 cases in a period of six months. He reports these cases briefly, discusses the signs and symptoms of the component diseases, and describes the technic of their roentgen demonstration.

In the differential diagnosis of hiatus hernia, three conditions must be kept in mind: phrenic ampulla, esophageal diverticulum, and other diaphragmatic hernias. Usually little difficulty is experienced in differentiating diverticula from other conditions but they may on occasion simulate calcification in different sites from the region of the gallbladder to the left iliac fossa. Irregularity of the colon may suggest some resemblance to carcinoma. Gallstones must be distinguished from renal stones, calcified costal cartilages, etc.

Nine roentgenograms

Papilloma of the Gallbladder. Case Report. Gordon McHardy and Edwin Edwards. New Orleans M & S J 100 573, June 1948

A case of papilloma of the gallbladder diagnosed roentgenologically and proved at operation is reported. The papilloma had separated from its pedicle and lay free in the lumen of the gallbladder.

One roentgenogram

Certain Radiological Aspects of Acute Pancreatitis. J Garcia-Calderon, R Sarasin, and G Marquis. J de radiol et d'électrol 29 243-245, 1948. (In French.)

The authors describe the roentgenologic findings in the gastro-intestinal tract in two patients with acute pancreatitis. These consist principally of morphologic and functional changes in the stomach, duodenum, and jejunum. In the stomach, a lacking in the horizontal portion of the pyloric antrum is described, extending on to the internal margin of the vertical segment. Dilatation with atonia of duodenum and jejunum, but also with compression by the pancreatic mass of the terminal portion of duodenum, is described in one case and, in the other, compression of the first loop of jejunum.

SIMON T. CANTRIL, M D
Seattle, Wash

THE MUSCULOSKELETAL SYSTEM

Myxedema with Delayed Closure of Epiphyses in Sexually Mature Women. J C Mussio Fournier, J C Barsantini, and H C Bazzano. J Clin Endocrinol 8 482-486, June 1948

The authors present the histories of 4 myxedematous women in whom there was evidence of a retarded closure of certain epiphyseal lines, though menstruation had begun a long time previously (eleven to twenty-nine years). These findings suggest that estrogens alone are not sufficient to lead to closure of the epiphyseal lines and that the thyroid hormone plays a part in the process. It may act directly upon the epiphyseal cartilages in co-ordination with the estrogens or, by direct or indirect action, it may induce the adrenal cortex to secrete some hormone which influences closure of the epiphyses.

In order to explain the greater delay in synostosis in panhypopituitarism than in ovarian insufficiency Albright et al (Am J M Sc 204 625, 1942. Abst in Radiology 41 204, 1943) suggested that the adrenal cortex may contribute to closure of the epiphyses. The existence of an adrenal cortex deficiency in the course of

myxedema is demonstrated by decreased 17-ketosteroid excretion, and by the return of this excretion to normal after the administration of desiccated thyroid. This is in accord with the hypothesis that a deficiency of the adrenal cortex may be a factor in myxedema contributing to delay in closure of the epiphyses in spite of normal ovarian function.

Two roentgenograms, 4 photographs

Value of Routine Roentgenograms of the Wrist in a Pediatric Service. M G Peterman, W B Frey, and J D Kaster. Am J Dis Child 75 671-687, May 1948

As an argument for adoption of routine filming of the wrists of all children requiring medical attention, the authors analyze their observations in 684 cases, half of which represented hospital admissions and half private patients. The percentage of abnormal findings was practically the same in each group, 10.21 per cent for the hospital series and 9.97 per cent for the private cases. Slightly more than half the children showed only delayed ossification. Other entities seen included rickets, scurvy, congenital syphilis, lead poisoning, mongolism, chondrodystrophy, osteochondroma, osteitis, and pubertas praecox.

[Routine examination of any part of the body is always productive of a certain amount of unsuspected pathology but the practice has two very definite disadvantages. First of all it would add considerably to the medical bill of the nation if every pediatric case were to be filmed and secondly any routine procedure tends to dull the clinician's acumen and to make him more and more dependent upon others for his diagnoses. We suspect that things of this nature would be done in all fields under a socialized system.—Z F E.]

Five roentgenograms, 6 tables

ZAC F. ENDRESS, M D
Pontiac, Mich

Dysostosis of Skull, Face and Extremities (Acrocephalosyndactyly). Robert W Buckley and Paul I Yakovlev. Am J Dis Child 75 688-694, May 1948

The literature on acrocephalosyndactyly is reviewed and a single case is reported. The interesting findings on roentgenography were: (1) acrocephaly (short anteroposterior diameter, increased distance between base and vault, with deep digital markings in the frontal bone), (2) fusion of both shoulder joints, (3) short, bowed humeri, (4) shortening, deformity, and partial fusion of phalanges.

The condition is believed to be due to a germ-plasm defect influencing the growth of both 'cartilaginous' and 'membranous' bone. In only 1 case in the literature was a familial tendency evident.

Three roentgenograms, 5 photographs

ZAC F. ENDRESS, M D
Pontiac, Mich

Infantile Cortical Hyperostoses. Report of a Case. Katherine T Chen and Ting-Sing Yu. Chinese M J 66 266-267, May 1948

A case of infantile cortical hyperostoses is reported from China. The findings differed from the typical picture described by Caffey (see Caffey and Silverman. Am J Roentgenol 54 1, 1945. Abst in Radiology 46 538, 1946) in several respects. The lesions were at first limited to the long bones of the extremities, with no mandibular involvement demonstrable clinically or

roentgenographically until the age of six months, the radii were predominantly involved and the ulnae only slightly so, fever was absent throughout most of the course

Multiple Cartilaginous Exostoses (Hereditary Deforming Chondrodysplasia) Fun-Yong Khoo, Ping-Yi Chang, Chung-Tan Lee, and Kuo-Sheng Fan Chinese M J 66 252-256, May 1948

Multiple cartilaginous exostoses appear to be as common among the Chinese as among other peoples. Seven cases seen in a period of four years are here recorded, with the roentgen findings. Four of the patients were members of the same family and in two others there was evidence of a definite hereditary factor.

Five roentgenograms

Ollier's Disease Report of Case Roger W. Dickson and Shirley M. Cohen J M A Georgia 37 205-207, June 1948

A boy of 22 months showed the characteristic features of Ollier's disease (hereditary deforming chondrodysplasia). Bony projections were palpable along the anterior axillary regions of the ribs and at the upper ends of all the long bones, most marked at the distal ulnae, proximal humeri, distal femora, and proximal tibiae. The long bones were slightly diminished in length. Exostoses were also present in the child's father and two paternal uncles. On roentgen examination both showed some deformity of the long bones with cyst like areas of cartilaginous exostoses.

The transmission of the disease was through the paternal grandmother. She herself had no apparent lesions, but two of her sisters had a few small bony projections, and one brother had many large ones.

Two roentgenograms, 1 chart

Ewing's Sarcoma of the Rib Edward M. Kent and F. S. Ashburn Am J Surg 75 845-848, June 1948

A brief review of the literature of the past ten years reveals 311 cases of Ewing's sarcoma, 21 of which were considered to be primary in the ribs. The authors furnish a digest of the natural history of the process, its diagnosis, and proposed forms of therapy. Their case was that of a 17-year-old boy who complained of left chest pain for one year and chest deformity of five months duration. After diagnosis by aspiration biopsy, roentgen therapy was given to the extent of 5,000 r at 400 kv. The large mass decreased rapidly and its remainder was later excised. The tumor arose from the fifth rib and had extended to involve the left lung, about one-third of which was also resected. The patient was well thirteen months after operation but the authors believed his prognosis to be poor.

Five roentgenograms HORACE G. BUTLER, M.D.
University of Pennsylvania

Osteoid Osteoma. J. E. Pritchard and J. W. McKay Canad M A J 58 567-575, June 1948

The osteoid osteoma is a small but usually painful, tender, and troublesome benign lesion of bone. It has often been mistaken for other conditions such as chronic osteomyelitis, cortical abscess, sclerosing osteitis, osteochondritis dissecans, tuberculosis, bone cyst, and even sarcoma. The differential diagnosis is not always easy without the aid of histologic sections.

Fifteen cases of osteoid osteoma are presented in

this report with x-ray and histologic findings. Early in the course of the disease, even though pain and tenderness and sometimes swelling of the soft tissues are marked, there may be no noticeable radiologic change. At a demonstrable stage, a more or less rounded nodule, commonly 0.5 to 1.0 cm in diameter, is seen. It may be entirely within cancellous bone, entirely within the cortex, subperiosteal, or in the deep margin of the cortex bulging into the medulla. The consistency of the nodule varies from that of soft, spongy to hard bone. It may be brownish red, pink, or pearly gray.

The fundamental nature of the osteoid osteoma is that of a very cellular osteoblastic type of connective tissue well vascularized and containing numbers of multinucleated giant cells. It reminds one of the type of tissue seen in the metaphysis of growing bone. Small irregular, scattered deposits of osteoid can be detected. At this stage the roentgenogram will reveal a small more or less rounded radiotranslucent area which is comprised of the non-calcified tumor and the immediately surrounding zone of reactive connective tissue. At the periphery, new bone formation may be stimulated, producing a rim of condensation about the rarefied nodule.

The next phase is calcification of the osteoid. Beyond the margin of the tumor nodule the vascular connective-tissue zone persists. The roentgen appearance will now be that of a central opaque body surrounded by a zone of radiotranslucency.

Osteoid osteoma is a disease affecting chiefly young adults and adolescents and occurs about twice as often in the male as in the female. The predominant location is in the bones of the lower extremities. As yet this tumor has not been reported in the ribs, clavicles, scapulae, or skull bones other than the mandible. Pain is the outstanding symptom and swelling of the regional soft tissues is often found. Trauma cannot be considered an etiologic factor. There is usually no significant rise in temperature, pulse rate, or leukocytes, and regional lymph nodes rarely enlarge. Surgical removal usually gives prompt relief of symptoms and a lasting cure.

Seventeen illustrations, including 8 roentgenograms
WYNTON H. CARROLL, M.D.
The Henry Ford Hospital

Eosinophilic Granuloma of Temporal Bone Associated with Diabetes Insipidus. A Case Report J. Lewis Dill Ann Otol, Rhin & Laryng 57 531-537, June 1948

Eosinophilic granuloma has been observed in practically all the bones of the body except the carpals, metacarpals and phalanges and the corresponding bones of the feet. The most common symptom is mild local pain, associated with swelling of the soft tissues and tenderness. In a limited number of cases an increase in the eosinophils in the blood has been found. Two cases have been reported in association with diabetes insipidus, and a third is here recorded.

In this case, the diagnosis of diabetes insipidus was made at the age of two and a half years. At four and a half years the child was seen with a fourteen-months history of a draining right ear. Examination of the ear showed a purulent discharge in the canal and a swelling of the posterior canal wall, resembling a furuncle, the ear drum was not visualized. A roentgenogram revealed clouding of the right mastoid with some destruction. A mastoidectomy was advised but was

refused by the parents. On March 5, 1946, the tonsils and adenoids were removed. At that time the right ear was still draining and the furuncle of the posterior auditory canal wall was still present. On Dec 30, 1946, roentgenograms showed sclerosis throughout the extent of the right mastoid. No cells were visualized. A large irregular area of destruction of the temporal bone above the mastoid was found.

A right simple mastoidectomy was performed in January 1947. A large, oval, irregular area of the temporal bone was found destroyed and the dura exposed. The mastoid cells had been completely replaced by a whitish cholesteatomatous material, which protruded through the fistula of the posterior canal wall. A pathologic diagnosis of eosinophilic granuloma was made.

Shortly after operation, small secondary lesions were observed in the right parietal bone, demonstrable as rounded shadows of decalcification. Following x-ray therapy these areas appeared to have recalcified. The dose was 400 r to each of two fields, a right mastoid and a right parietal, administered in 100 r fractions at intervals of three or four days. The factors were 140 kv, 6 ma, 0.5 mm Cu and 1.0 mm Al filtration, half-value layer 0.5 mm Cu, 24 cm distance, 39 r per minute.

Four roentgenograms. STEPHEN N. TAGER, M.D.
Urbana, Ill.

Eosinophilic Granuloma of Rib. Elmer Maurer and George A. DeStefano. *J Thoracic Surg* 17: 350-356, June 1948.

Thirty-nine cases of eosinophilic granuloma of bone have been reported and only 6 of these have been solitary in a rib. A case is reported in a 16 year old boy in whom the left fifth rib posteriorly showed an expanding lesion of a destructive nature 9 cm long. The only complaint was pain over the anterior left chest for one month. There were no abnormal physical findings. The most probable preoperative diagnosis was osteogenic sarcoma, and the lesion was widely resected. It proved to be an eosinophilic granuloma.

Solitary eosinophilic granuloma of bone may simulate bone cyst, giant-cell tumor, Ewing's tumor, solitary myeloma, osteogenic sarcoma, or osteomyelitis. Multiple lesions may resemble multiple myeloma, metastatic tumor, osteitis fibrosa cystica, Letterer-Siwe disease, or Hand-Schüller-Christian disease. Actually these last two diseases are probably the same as eosinophilic granuloma with different clinico-anatomic expressions.

The authors advocate surgical excision, although some lesions heal spontaneously and others have responded to roentgen therapy.

One roentgenogram, 2 drawings, 2 photomicrographs. HAROLD O. PETERSON, M.D.
University of Minnesota.

Solitary Bone Cyst of the Os Calcis (A Form of Osteitis Fibrosa). John M. Hundley. *J Arkansas M Soc* 45: 7-8, June 1948.

The solitary bone cyst, a form of osteitis fibrosa cystica, is usually found in the proximal portion of the femur, the humerus, and the tibia. Cases involving the frontal bone, mandible, patella, etc., have been reported. The author presents a case because of its unusual location—the os calcis. Only 4 previous cases of solitary bone cyst in this site have been recorded.

Multiple Cystic Tuberculosis of the Bones. McLemore Birdsong and Camillus S. L'Engle, Jr. *Pediatrics* 1: 767-770, June 1948.

Proved cases of multiple cystic tuberculosis of the bone are uncommon in the pediatric literature, only 13 cases having been previously recorded. The case of a thirteen-month-old child is presented with the rare combination of cystic tuberculosis in the flat and long bones as well as in the bones of the hands and feet.

Three roentgenograms.

Multiple Myeloma with Spinal Cord Compression as the Initial Finding. Leopold J. Snyder and Seymour K. Wilhelm. *Ann Int Med* 28: 1169-1177, June 1948.

A single case of multiple myeloma causing paraplegia by extension into the spinal canal is presented in detail. Initial films made before the paraplegia became complete showed a paravertebral soft-tissue mass and destruction of one pedicle of the fourth dorsal vertebra, the body of which was partly collapsed. An air myelogram showed an incomplete block, with displacement of the cord at that level. Retrograde pyelography ruled out a primary tumor in the genito-urinary tract. Laminectomy was done and as much of the mass as possible was removed. It had not become attached to the dura. After a microscopic diagnosis of plasmacytoma myeloma was made, the skull was x-rayed and typical "punched out" areas were demonstrated. The decompression of the cord, followed by deep roentgen therapy, resulted in almost complete recovery from the paralysis. The ultimate prognosis is, of course, hopeless but the patient was able to return to work.

This case serves to emphasize two points worth remembering: (1) Do skull films when a neoplasm of unknown origin is seen in the spine. (2) Laminectomy for decompression is worth the effort if there is pressure on the spinal cord.

Four roentgenograms, 2 photomicrographs, 1 chart.
ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Gout. Report of an Unusual Case in a Young Man. Morton E. Berk. *Am J M Sc* 215: 290-295, March 1948.

A man aged 28 complained of pain in the interphalangeal joints, especially in the left small finger. At the age of eleven he had experienced recurrent bouts of pain in the metatarsophalangeal joints of both great toes. At the age of twenty-two, because of pain in the right great toe, an operation was performed and the contents at the base of the second phalanx were removed. They proved to be sodium urate crystals, but the patient was not informed of the diagnosis. He had had two hospital admissions during the past year and had been discharged with a diagnosis of rheumatoid arthritis.

Most of the joints in the extremities were swollen, tender, and deformed, and their movements were restricted. Purulent material was trickling from the distal interphalangeal joint of the right fifth finger, which was very tender. Sodium urate crystals were found in a small cyst behind one ear. Roentgenograms showed extensive destruction of the first metatarsal and the proximal phalanx of the great toe. Amputations of the great toe and infected finger were performed, along with removal of the tophaceous material.

Although the onset of this disease is rarely before thirty-five, this patient had distinctly gouty symptoms which had appeared before the age of eleven. A very poor individual, he had subsisted on a basic diet, rarely supplemented by alcoholic beverages. Tophi commonly are found at the ear margins, his resembled a sebaceous cyst behind the ear. On five occasions this patient had blood uric acid studies under the normal upper limit. It has not been sufficiently stressed that acute arthritis or gout is of an inflammatory nature, with a high sedimentation rate. The temperature was above normal during all periods of pain.

Careful removal of the tophaceous material brings relief from crippling pain.

Two roentgenograms, 2 tables

BENJAMIN COPLEMAN, M D
Perth Amboy, N J

Osteoarthritis of the Cervicodorsal Spine (Radiculitis) Simulating Coronary-Artery Disease. Clinical and Roentgenologic Findings. David Davis and Max Ritvo. *New England J Med* 238: 857-866, June 17, 1948.

This is a study of 43 patients with radiculitis, in 23 of whom coronary artery disease was suspected from the presenting symptoms. There have been several presentations of roentgen findings in cervical radiculitis, but there are few data on the changes in dorsal radiculitis.

The diagnosis of radiculitis is based on the presence of at least two of the following criteria: symptoms with definite radicular characteristics, reproduction of attacks by pressure over the spine, and prompt response to orthopedic therapy. The pain is rather characteristic, with attacks coming on in bed at night, precipitated or aggravated by change in position, it may be produced, also, or accentuated by coughing or straining at stool.

In the group of 43 patients studied, 32 were males and 11 were females. They were observed over a period of weeks or months before a definite diagnosis of radiculitis was established. The outstanding clinical findings were attacks of severe substernal or precordial pain radiating to the left upper extremity or neck or jaw. The pain is described as a pressure sensation, heaviness, or a vise like constriction. It closely resembled the pain of coronary heart disease. Some patients complained of a peculiar respiratory distress, in the nature of inability to take a deep breath.

Any factor that narrows the intervertebral foramen may cause nerve root irritation. Marginal osteophytes, thinning of the intervertebral disks, osteoarthritis of the posterior articulations, and postural changes may affect the size of the foramina. The roentgenologic demonstration of osteoarthritis may be a great aid in establishing a diagnosis of radiculitis particularly where the symptoms are of short duration and the attacks cannot be reproduced or the pain is not of the characteristic type.

Five roentgenograms, 2 tables

JOHN B. MCANENY, M D
Johnstown, Penna

Value of Conservative Management in Cervicobrachial Pain. G E Haggart. *J A M A* 137: 508-513, June 5, 1948.

The author reviews the various causes of cervicobrachial pain and stresses the favorable results obtained

by conservative therapy. He divides the cases into two groups: (1) those with abnormalities apparent in a roentgenogram (cervical rib, abnormal first rib, cervicodorsal scoliosis, asymmetry and variations in thoracic outlet, arthritis, and protrusion of cervical disk shown by myelogram) and (2) those with abnormalities not apparent in the roentgenogram (scalene anticus syndrome, costoclavicular compression, hyperabduction syndrome, causalgia or sympathetic dystrophy, and postural defects, *i e*, abnormal relationship of shoulder to thoracic cage).

Those difficulties included under postural defects are believed to be the most frequent. The author feels that "sagging and drooping of the shoulders exert tension on the brachial nerve roots and blood vessels, stretching the structures still more tightly over the upper edge of the thoracic outlet." Likewise, during growth, as the gradual descent of the thoracic structures progresses, the frequency of difficulty increases, especially in women.

The clavicle and an abnormal rib may constitute a vise, in which the third part of the artery as well as the plexus are gripped.

Hypertrophic changes can develop to the point where there is spur formation large enough to protrude into the intervertebral foramina.

Pain due to herniated disks is quite rare.

In cervical ribs over 5 cm long, one can expect trouble, especially if this rib is fused with the first rib.

Many cases of scalene anticus syndrome are relieved because of the removal of one jaw of a vise. The author found no histological evidence of hyperplastic or fibrotic muscle.

In the hyperabduction syndrome, the scalenes are relaxed whereas the pectoralis minor compresses the vessels and nerves.

Haggart's 20 patients ranged in age from twenty-four to sixty years (average thirty-nine). Females predominated, 31. Fifty per cent were employed in occupations where constant use of the arms or prolonged flexion of neck and shoulders was required. Thirty-five per cent were housewives. In 15 per cent there was no relation to occupation. There were 3 cases of cervical ribs, 3 of protruded cervical disks, 3 of degenerative spondylitis, 1 of scoliosis, 3 of anterior scalene syndrome, 3 of costoclavicular compression syndrome, 3 of hyperabduction syndrome, and 1 case of trauma.

Most of the patients were treated on an ambulatory basis, with graduated exercises, postural training, sleeping posture training, and change in type of employment. Except for causalgia, where sympathectomy is the treatment of choice, all cases were given a trial of conservative therapy before surgery was recommended.

Seventeen of the 20 patients had good and excellent results on conservative therapy. One disk case, 1 hypertrophic spondylitis case, and 1 costoclavicular compression case had only "fair" results.

S B FEINBERG, M D
University of Michigan

Causation and Treatment of Painful Stiff Shoulder. Subdeltoid Bursitis, Periarthritis, Tendinitis, and Adhesive Capsulitis. Henry W Meyerding and John C Ivins. *Arch Surg* 56: 693-705, June 1948.

The causes of stiff, painful shoulder are many. Inflammatory degeneration in the rotator cuff, with

calcification which may rupture into the subdeltoid bursa, is only one of these. Tuberculosis of the shoulder joint, tuberculous bursitis, acromioclavicular separation, fracture of either the glenoid or the greater tubercle of the humerus, ruptured supraspinatus tendon, infection of the joint, osteomyelitis, tumor, and occasionally even coronary disease may be accompanied by a stiff, painful shoulder. The 150 cases on which the present report is based represent almost entirely chronic degenerative conditions of the rotator cuff, and most of them had received more or less treatment elsewhere.

In the acute stages, rest in bed, local heat, increased fluid intake, traction, and anodynes are used. Abduction is encouraged, and diathermy and roentgen irradiation may be used. In the subacute recurring stage, conventional diathermy, radiant heat, stretching, and active and assistive exercises should be carried out routinely. If abduction remains difficult, traction or manipulation followed by an abduction splint is used. Physical therapy was employed in all patients, but when conservative measures failed surgical treatment was used. Curettage or excision of the calcified area is employed, with needling and manipulation to break up adhesions after operation. Local injection of procaine or block of the suprascapular nerve may give added benefit. A routine postoperative or postmanipulative film should be made to exclude fracture.

Forty of the reported cases had roentgen therapy repeated small doses being centered over the point of maximum tenderness. In the acute stage, a dose of 75 r was given on alternate days for three or four doses, while in the subacute or chronic stage 100 r was given twice weekly. Results were more favorable in the acute stage. Considering all patients and all forms of treatment, a favorable result was obtained in 85 per cent of the patients.

Three roentgenograms, 2 drawings, 1 photograph
LEWIS G. JACOBS, M D
Oakland, Calif

Avulsion Fracture of Lesser Tuberosity of Humerus
Report of a Case. A. T. Andreasen. *Lancet* 1: 750-751, May 15 1948.

A case of avulsion fracture of the lesser tuberosity of the humerus is reported. This is apparently a rare injury. In the present instance it was caused by an effort, with the arm fully abducted above the shoulder, the hand being fixed and the body moving to save a fall on dismounting from a horse. The circumflex nerve was contused and hemarthrosis developed. Operation was refused by the patient. Recovery was complete except for internal rotation at the scapulohumeral joint. The detached fragment of bone first underwent aseptic necrosis and then was absorbed in fourteen months. Roentgenograms are reproduced.

Anterior Dislocation of the Elbow with Fracture of the Olecranon Lawrence H. Strug. *Am J Surg* 75: 700-703, May 1948.

While anterior dislocation of the elbow is probably not extremely uncommon, only 35 cases have been reported. In 8 of these there was an associated fracture of the olecranon. Most of the reported cases have occurred as a result of a direct blow upon the elbow. A fall on the flexed elbow as in the author's case is also a common occurrence. The type associated with fracture results in severe soft tissue damage and injury to the vessels.

In a few instances, rupture of the brachial artery has occurred. A considerable amount of swelling, hematoma formation, and possible extensive laceration of the triceps tendon result. Operative intervention may occasionally be necessary.

The author's patient was an 11-year old boy who fell off a bicycle, landing on his flexed elbow. The roentgenograms showed anterior overriding of the ulna and radius on the distal end of the humerus. The epiphysis and proximal fragment of the olecranon remained posteriorly. Treatment was instituted early and a successful anatomic result was obtained by closed reduction. The course was uncomplicated.

Five roentgenograms, 1 table

DAVID S. MALEN, M D
University of Pennsylvania

Contralateral Fracture of First and Second Ribs Following Thoracoplasty Albert Guggenheim and Bernard N. E. Cohn. *J Thoracic Surg* 17: 366-373, June 1948.

An analysis of 208 consecutive cases of thoracoplasty revealed fractures of the first rib on the contralateral side in 6 cases and of the first and second ribs in 2 cases. Four of these patients were males and 4 females. All were between the ages of twenty six and forty. All but one of the fractures were in the middle third of the rib. This is the thinnest part of the first rib, as it corresponds to the site of the subclavian grooves. In this area, also, muscular stress would probably be the greatest.

The authors believe that these fractures are due to prolonged muscular traction. They assume that removal of ribs during the first stage of a thoracoplasty alters the normal mechanics of the muscles attached to the first and second ribs on the contralateral side. Consequently the pull of these muscles is unopposed. Except in one case the fractures were painless.

Thirteen roentgenograms, 1 drawing

HAROLD O. PETERSON, M D
University of Minnesota

Fractures of the Acetabulum. The Nature of the Traumatic Lesions, Treatment, and Two-Year End-Results Marshall R. Urist. *Ann Surg* 127: 1150-1164, June 1948.

This is the second in a series of three papers concerned with the analysis of 58 injuries of the hip joint occurring in jeep accidents in World War II. (For the first, see *Am J Surg* 74: 586, 1947. *Abst in Radiology* 51: 442, 1948.) The present contribution deals with 16 cases of fracture of the acetabulum without dislocation. These are divided into three groups: 5 cases of fracture of the rim of the acetabulum, 8 cases of central fracture, 3 cases of comminuted or bursting fractures disorganizing the entire joint cavity. These 16 cases incurred in military service are compared with 7 similar cases studied on the Fracture Service of the Massachusetts General Hospital.

Fractures of the superior and posterior rims of the acetabulum of significant magnitude almost always resulted in some disability, but good function in the joint was obtained in one case after open reduction and accurate internal fixation.

Central fractures of the acetabulum can be classified in two groups. (A) Fractures limited to the pubic portion of the acetabulum and the descending ramus.

of the pubis, even with intrapelvic protrusion of the head, responded well to conservative treatment and showed an excellent functional result after one to three years (B) Fractures bursting the triradiate line of the acetabulum were impossible to reduce by conservative methods and resulted in great disability. Fusion or orthoplasty was advised in three such cases after two years.

All the evidence is to the effect that fractures of the pubic portion of the acetabulum are chiefly lesions of the anterior rim, which is not essential to the function of the hip joint, while stellate or bursting fractures involve or distort the lunate superior and posterior articular cartilage of the acetabulum, which is essential for normal weight-bearing.

Six roentgenograms, 2 tables

DONALD R. BRYANT, M D
The Henry Ford Hospital

Skeletal Lesions in Leukemia. Clinical and Roentgenographic Observations in 103 Infants and Children, with a Review of the Literature. Frederic N Silverman. *Am J Roentgenol* 59 819-843, June 1948.

The literature on the subject of bone lesions in leukemia is exhaustively reviewed, followed by an analysis of a series of cases seen in the Babies Hospital, New York, from 1924 to 1947. The total number of cases was 131, for 103 of which satisfactory roentgenograms were available [a remarkably high percentage, since only one-half had bone pain]. The children ranged in age from twenty-two days to twelve and a half years.

Four types of bone lesions were seen: transverse bands of diminished density, osteolytic areas, osteosclerosis, and subperiosteal new bone formation. Some patients showed more than one type of lesion. Fifty-two of the 103 showed bone changes, but it is pointed out that in others bone involvement may have developed after the initial films were made, since it was in the late stages that lesions were more often found and many patients had left the hospital before their disease became advanced.

Two case histories of leukemia and 3 which simulated leukemia are presented in detail.

This paper is well worth reading in the original.

Fifteen roentgenograms, 6 tables

ZAC F. ENDRESS, M D
Pontiac, Mich

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography Employing a Water-Soluble Contrast Medium. Derek Jefferiss. *J Obst & Gynec Brit Emp* 55 270-272, June 1948.

The author has used "Pyelosil," which is a 35 per cent solution of the diethanolamine salt of 3,5-di-iodo-4-pyridone N acetic acid, for testing the patency of the fallopian tubes. Its advantage lies in its rapid absorption (one hour) and therefore probable absence of irritating effects. Its use in 24 cases is reported. In 19 of these the tubes were found to be patent. Operation was done in 3 of the 5 patients in whom obstruction was found. In 2 this was due to pyosalpinx and in 1 to a tuberculous salpingitis. No therapeutic value is claimed for the method. In fact, the author believes it questionable whether any form of uterotubal insufflation is likely to be of therapeutic benefit except in very recent cases of anatomical obstruction. He points out in this connection that an impressive number of women

on a long waiting list for insufflation for sterility became pregnant before they could be admitted for the procedure. Had it been carried out, they might have been considered examples of its success.

Four roentgenograms S F THOMAS, M D
Palo Alto, Calif

Characteristics in Hysterosalpingograms in Tuberculous Salpingitis and Endometritis. Ko Chu Sun. *Am J Obst & Gynec* 55 953-960, June 1948.

Observations were made of 6 patients in a series of 138 sterility problems at the Shanghai (China) Woman's Hospital. All were examined with plain films and hysterosalpingograms by the fractional method of Joachumovitz and Hyams on the eleventh day of the menstrual cycle, a twenty-four-hour film completed the study. The diagnosis of tuberculous salpingitis and endometritis was confirmed by operative specimens.

The abnormal findings are briefly described. On the plain film, x-ray opaque bodies were seen in the pelvis. Filling of the uterus and tubes was slow. When filled, the cervical canal appeared fuzzy or "feathered," and the uterus convex with bulging contours. Filling of the tubes, when it occurred, did so in a jerky, fragmented fashion, and they appeared stiff or wiry, similar to filaments. Finally, the contrast medium was unevenly distributed, with lack of spread to the free peritoneal cavity.

The author gives an analysis of the pathology involved, reviews previously reported cases, and outlines the differential diagnosis.

Ten roentgenograms

FREDERICK R. GILMORE, M D
Jefferson Hospital, Philadelphia

On Hysterosalpingography and Extra-Uterine Pregnancy. Henning Skjoldborg. *Acta radiol* 29 456-460, May 31, 1948.

Hysterosalpingography is of help in diagnosing tubal pregnancy in cases where there is a slowly proceeding tubal abortion with periodic hemorrhages and hematocoele formation.

The typical hysterosalpingogram in tubal pregnancy will appear as follows:

The affected tube will be slightly swollen laterally. It will appear trumpet-shaped and passage of the medium will be obstructed laterally. There is usually a net like appearance which is separated from the rest of the contrast medium. This is apparently due to a small amount of the contrast medium having made its way in a very thin layer between the ovum and the tube wall.

A method devised by Kjellberg for hysterosalpingography is described. (Suppl. XLIII, *Acta radiol*, 1942. Reviewed in *Radiology* 46 416 1946). In this method a Günther-Schultze apparatus is inserted. Twenty five per cent perabrodil with 1 per cent procaine is injected into the uterus under slight pressure, approximately 20 to 40 c.c. of the contrast fluid being used. Perabrodil is water-soluble which makes it especially satisfactory, since a water soluble medium distributes itself more evenly and more rapidly through small cavities.

Three proved cases of extra uterine pregnancy are described with the hystero-graphic findings.

Four roentgenograms EUGENE KURTZ, M D
Baltimore (Md.) City Hospital

Clinical Interpretation of X-Ray Pelvimetry Howard P Taylor Ohio State M J 44 608-611, June 1948

In the author's opinion, clinical measurement of the pelvic outlet is more accurate than x-ray study, and routine roentgen pelvimetry is neither necessary nor desirable. It is indicated (1) in all primiparas in whom the head is unengaged two weeks prior to term, (2) in all breech presentations, (3) in all compound presentations, (4) in all multiparas with a history of previous difficult labor, and (5) during labor if arrest occurs in a multipara.

At least ten methods of pelvimetry are in use, and it is suggested that the type of procedure is of less importance than experience in its application. Qualitative methods are exemplified by precision stereoscopic filming, in which the pelvic measurements are reduced to linear measurements identical with those in clinical use. The quantitative methods, of which Ball's is an example, express cubic capacity of the pelvis in relation to cubic capacity of the fetal head, and have little meaning for the average clinician.

Two methods of morphologic classification are in use: that of Caldwell, Moloy, and Swenson (gynecoid, platypelloid, anthropoid android, and asymmetrical, with further division into mixed types) and that of Thoms, based on the ratio between the anteroposterior and transverse diameters of the inlet (dolichopellic, mesatipellic, brachypellic, and platypellic). The roentgenologist and obstetrician must both be familiar with the classification employed and its implications.

The x-ray report should include a general description of the development and approximate size of the fetus, its presentation, position, attitude, and the degree of descent of the head, cephalic measurements including occipito frontal, biparietal and suboccipito bregmatic, any observable soft-tissue shadows, morphologic classification of the maternal pelvis and actual measurements of the pelvic diameters. The roentgenologic conclusions should be stated as no evidence of disproportion, evidence of moderate disproportion, or severe disproportion. Clinical interpretation of these findings is the obstetrician's responsibility.

Errors in roentgen predictions are due to the obvious inability to estimate the amount of pelvic space occupied by soft tissue, uncertainty as to the behavior of the cervix during labor and the degree of molding of the fetal head, lack of knowledge of the age of the patient and her previous obstetrical history, and of the skill of the attending obstetrician.

Proper evaluation of each case can be obtained only by close co-operation between roentgenologist and obstetrician. The former should be familiar with roentgen technique which renders reasonably reliable measurements; permits morphologic classification of the pelvis, and observations of the fetal skeleton.

ALTON S. HANSEN, M D
Peoria, Ill

Possible Significance of Arterial Visualization in the Diagnosis of Placenta Previa A Preliminary Report. Leo J Hartnett Am J Obst & Gynec 55 940-952, June 1948

A series of 68 aortograms, of women in the later stages of pregnancy obtained with intent of outlining the maternal circulation over the placental site, is reported. Diodrast and sodium iodide were employed; the dosage being 18 c.c. of a 70 per cent solution or 10 c.c. of an 80 per cent solution. Sodium iodide provided the better

visualization. The procedure was attempted only when the urinary function was within the limits of normal and non-sensitivity to the medium had been established by intradermal and intravenous tests.

Aortic puncture was done in the prone position under sodium pentothal anesthesia. The first roentgenogram was made as the injection was completed, the second within seven seconds. The average settings were 75 kv and 200 ma at 0.5 seconds, with a high-speed Bucky grid.

Periaortic retroperitoneal extravasation was the most important complication encountered. Thirteen such instances occurred and were attended by lumbar pain and mild temperature rise over a twenty-four-hour period. Accidental injection of specific arterial vessels produced no ill effects.

Care with the speed of injection is recommended. Sodium iodide injection required at least five seconds more rapid administration producing marked intimal irritation and tetanic uterine contractions, with occasional evidence of fetal distress. No instance of premature labor was encountered. Introduction of diodrast was uneventful, and only rapid injection afforded satisfactory concentrations.

No subsequent traces of iodide were found in the placentas, nor could microscopic damage of the chorionic villi be demonstrated. All women delivered without mishap and all babies were living and unaffected.

The author offers the procedure as one which will positively locate the placenta. When possible, implantation sites were checked at delivery and were found to correspond uniformly with the roentgenograms. Two cases of placenta previa were encountered and aortic puncture was without ill effect. The author feels that further study is warranted before satisfactory comparison of the risks entailed as against those of "watchful expectancy" in the treatment of bleeding during pregnancy can be made.

Nine roentgenograms, 2 photographs

G D DODD, M D
Jefferson Hospital, Philadelphia

THE GENITO-URINARY SYSTEM

Roentgen Considerations of Pylonephritis in Small Kidneys Eugene P Pendergrass, Richard H Chamberlain, and Frank P Brooks Am J Roentgenol 59 661-661, May 1948

The authors discuss the diagnostic problems relative to the unilateral small kidney, classifying the condition as (1) hypoplasia of the kidney and (2) acquired atrophy, the latter including (a) atrophic chronic pyelonephritis, (b) primary atrophy, and (c) pyonephrosis. They have observed approximately 60 cases. In addition to diminution in size, these frequently showed sharp demarcation of the renal contour from the surrounding soft-tissue densities. In many cases the mobility of the kidney was restricted, and clearance of intravenous contrast medium was often impaired.

The small kidney, with or without urographic evidence of pyelonephritis, was found on the first examination in every one of the patients studied. The condition was observed in both children and in adults. Histories of previous infection were not informative.

Many cases of pyelonephritis are observed in which the kidneys are not small. In bilateral pyelonephritis, only one kidney appeared to be small in practically every instance. Small kidneys, presumably

hypoplastic, were found in which there was no clinical evidence of disease. Yet if a patient is hypertensive, such a small kidney found on urographic study might lead one to suspect either pyelonephritis with contracted kidney or renal relationship to the hypertension. Similar observations obtain in the contracted kidney of pyelonephritis, and the authors were unable, with urography, to differentiate with certainty between hypoplasia and the small kidney with pyelonephritis.

Several case reports are included

Twenty-two roentgenograms

G. K. VOLLMAR, M.D.
The Henry Ford Hospital

Dyspepsia and Serous Cysts of the Kidney Earl E. Ewert and Lloyd D. Flint. *S. Clin. North America* 28: 785-792, June 1948

In the presence of serous cysts of the kidney, abdominal pain and digestive tract disturbances often confuse the clinician until a urologic investigation is done. In some cases, serous cysts of the right kidney may simulate biliary tract disease. In contradistinction to congenital polycystic kidneys, these renal cysts occur at an age when there are arteriosclerotic changes associated with inflammatory fibrosis.

In the series of 54 cases reported here, the most common location of cysts was in the lower pole (28 cases). Abdominal pain or pressure is the predominant symptom, but is in no way characteristic and varies in location. When there is symptomatology related to the genito-urinary system, the cyst is always overshadowed by associated pathologic changes.

The diagnosis of serous cysts of the kidney is based on pyelography, either retrograde or excretory. The typical pyelogram shows a compression of the calices with an elongation of the calyx as if in an attempt to encircle the cyst in a 'ball and claw arrangement.' There may be no distortion or displacement present or there may be marked compression of the ureter, pelvis, or both, with hydronephrosis and even calcification. All the findings described can be simulated by a malignant tumor, and surgery is advised in every case to eliminate that possibility. Some extrarenal conditions that may confuse the diagnosis are retroperitoneal cysts, cysts of the mesentery, omentum, adrenal pancreas, and spleen.

The treatment for serous cysts of the kidney is surgical excision through a lumbar exposure. The surgical technique is discussed and can be summarized as simple excision and cauterization. All the patients studied were relieved of their symptoms with the excision of the cyst, with the exception of two: one with an anxiety neurosis and the other an alcoholic with a hiatus hernia.

One case with symptoms and findings pointing toward the gastro-intestinal tract is reported.

Three roentgenograms, 3 tables

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Role of the Sphincters in the Pelvis of the Ureter Cecil J. A. Woodside. *Urol. & Cutan. Rev.* 52: 320-322, June 1948

The author became interested in the sphincteric control of the ureter after doing sympathectomies for hydronephrosis due to an achalasia of the pelviureteral sphincter. Pyelograms in these cases showed that in the early stages of this disease the pelvis proper was con-

siderably distended, but the major and minor calices were not. In long standing cases, or cases of more rapid development, the major calices might also be distended and their junctional zones widened while the minor calices appeared normal. In later stages, these, too, became somewhat distended and blunted. In each stage, marked constriction was noted at the junctional zones, where the major calices join the pelvis or where the minor calices arise from the major calices. The author surmised, therefore, that there must be some form of effective barrier preventing the increased pressure from the pelvis reaching the renal tubules, and came to the conclusion that sphincters must exist at the junctional zones.

Such sphincters have been described by others but from a physiological point of view. They divide the pelvis into three chambers, the first being equal to the total number of minor calices, the second to the major calices, while the third is equivalent to the pelvis proper. Filling and emptying take place serially when a certain pressure is attained at each level so that the sphincters relax, contracting again when the next chamber fills up, to prevent a reflux. The author believes that these sphincters play the further roles of (1) protection against increasing pressure from below and (2) inhibition when subject to neuromuscular imbalance, of obstruction of the pelvis or its adnexa.

Five roentgenograms MAURICE D. SACHS, M.D.
Cleveland, Ohio

Congenital Megaloureter and Hydroureter: Pathogenesis and Classification G. E. Irvin and John E. Kraus. *Arch. Path.* 45: 752-765, June 1948

The authors present 4 cases with autopsy findings and comment on the genesis, the classification, and the nomenclature of congenital ureteral enlargements. Three morphologic types of this condition are recognized: (1) megaloureter, representing congenital hyperplasia, which is manifested by thickened walls and by increased length with tortuosity, without evidence of organic obstruction—an anomaly having its analogue in other parts of the body; (2) a dilated ureter (hydroureter), the result of the presence of an organic obstacle obstructing the flow of urine, as seen in the obstructions acquired from any number of organic conditions; (3) an intermediate type representing a megaloureter which, because it has been unable to maintain a normal flow of urine, has become secondarily dilated through retention.

One roentgenogram, 5 photographs

Typical Roentgen Picture of Very Large Ureteroceles Ulf Rudhe. *Acta radiol.* 29: 396-402, May 31, 1948

The typical picture of ureterocele as given by most authors is applicable only to those of small or moderate size. It does not apply to those of very large dimensions. Three cases of the latter type are described. In these the ureterocele appeared on urography—and in one case also on urethrocytography—as a large, rounded, distinct soft-tissue formation causing a corresponding defect in the bladder contrast. In male patients past middle age the picture might be confused with prostatic hypertrophy. Double pelvis and ureters are a common associated finding. When reduplication occurs, the ureterocele usually involves the ureter from the superior pelvis. In the presence of the

very large ureterocele, one must look for impaired renal function on the affected side

Eight roentgenograms 1 drawing

EUGENE KURTZ, M D
Baltimore (Md) City Hospital

Cystography with Graduated Compression Olle Olsson *Acta radiol* 29 429-434, May 31, 1948

In cases of bladder neoplasm, cystography may be of more value than cystoscopy in determining the size, shape, extent of infiltration, and other pertinent data about the lesion. Cystography has nevertheless, made little progress as compared with other roentgenographic procedures used in studies of the urinary tract.

The fact that the bladder holds a large amount of fluid makes for a thick layer of contrast medium when such is instilled for ordinary cystography. Attempts have been made to overcome this inconvenience by using various concentrations of radiopaque substances, by taking films in various projections, and by filling the bladder to various degrees. Combinations of positive and negative contrast media are also employed.

Since more information about lesions of the stomach can be obtained by actual palpation of the stomach and by the use of various degrees of compression, the author felt that palpation of the urinary bladder would also furnish additional information. He therefore devised what he terms a "distinctor" for this purpose. This is essentially a wooden paddle shaped like a urethral sound except that it is broader and flatter and has less curve at its distal end. This is inserted into the rectum and during fluoroscopy the bladder filled with the contrast medium is selectively compressed. Filling defects may then be studied with varying thicknesses of the layer of contrast substance. Several illustrations demonstrate the value of the procedure.

Twelve illustrations, including 8 roentgenograms

S H MACHT, M D
Baltimore (Md) City Hospital

On the Roentgen Aspect of Prostatic Cancer by Urethrocytography Nils P G Edling *Acta radiol* 29 461-474 June 30, 1948

The author has made a study of urethrocytograms in 68 cases of prostatic cancer compared with as many cases of prostatic hypertrophy. On the basis of this he concludes that an elongation of the prostatic urethra combined with a narrow and irregular lumen, abrupt link of the luminal course, irregular bulgings into the base of the bladder, and displacement anteriorly or laterally of the entire prostatic urethra may constitute a characteristic cancer picture. The latter is the most significant finding. The absence of these signs, however, does not eliminate clinically suspicious cancer.

Fourteen roentgenograms

ROBERT LARNER, M D
Baltimore (Md) City Hospital

Urethrography A Diagnostic Aid in Diseases of the Lower Urinary Tract. William E Goodyear, Donald E Beard, and H Stephen Weens *South M J* 41 487-494, June 1948

Urethrography is a valuable diagnostic aid in diseases of the lower urinary tract and is considered an adjunct to other methods of examination. With a simplified technic using iodized oil (20 to 30 cc) the authors have found a single exposure satisfactory for routine examina-

tions. This is made with the patient in a forty-five degree oblique position, and the film centered on the symphysis pubis. Moderate traction is applied to the penis during the procedure. Normal respiration is continued during exposure, as it allows a normal tone of the external sphincter.

Urethrography has proved to be of great value in the study of urethral strictures, prostatic hypertrophy, prostatitis and in postoperative cases. No characteristic picture is seen in carcinoma of the prostate.

The complications of urethrography with iodized oil are insignificant.

Fifteen roentgenograms, 1 drawing

JOHN DECARLO, JR, M D
Jefferson Medical College

Roentgenologic Changes in the Urinary Bladder and the Distal Portion of the Ureters in Spermatocystitis Gunnar Edsman *Acta radiol* 29 371-382 May 31, 1948

Spermatocystitis is a seldom diagnosed entity which may complicate or be obscured by coincident disease of the lower urogenital tract. Since filling of the seminal vesicles with radiopaque contrast substances *via* the ejaculatory ducts or by vasopuncture is a most difficult and tedious procedure, an indirect approach is offered based on the inflammatory effect on adjacent organs. The limited basal cystitis forms the anatomopathological basis for the roentgenologic changes in the fundus of the bladder which may be seen in the urethrocytograms in cases of spermatocystitis.

In the oblique position, irregular indentations of the mucous membrane may be seen in the fundus of the bladder. Five such instances are well illustrated by case histories and radiographs. A brief review of the anatomy concerned is given plus three additional case reports with radiographs illustrating ureteral stenosis associated with spermatocystitis. [No mention is made of the reliability of the method in proving the presence of this entity in a series of cases, and one therefore assumes that those reported are selected merely to illustrate the author's point.]

It is suggested that consideration be given spermatocystitis in obscure cases of ureterectasis and hydro-nephrosis.

Thirteen roentgenograms, 1 drawing

HARRY J PERLBERG, JR, M D
Baltimore (Md) City Hospital

THE BLOOD VESSELS

Cerebral Angiography A Clinical Evaluation Based on 107 Cases John R. Green and Roman Arana *Am J Roentgenol* 59 617-650, May 1948

This article is an excellent detailed general review of the subject of cerebral angiography. There is considerable basic discussion of anatomical studies and details of the technic. The authors recommend percutaneous injection of the common carotid under general anesthesia. Diodrast is preferred for routine use.

The authors list the following indications for the procedure: (1) diseases of blood vessels, (2) cerebral neoplasms, (3) miscellaneous (when other diagnostic methods fail). They devote considerable space to the first two classifications, with case reports and supporting illustrations.

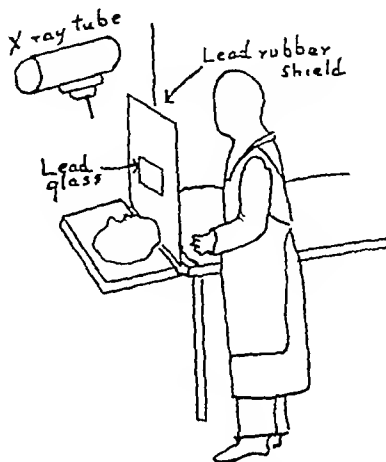
The report is based on 107 examinations.

Twenty-three illustrations including 20 roentgenograms, 2 tables

G K VOLLMAR, M D
The Henry Ford Hospital

A New Protector in Cerebral Angiography Arne Engeset *Acta radiol* 29 503-508 June 30, 1948

It has been shown that during one exposure in angiographic work the hands of the surgeon receive 0.2 to 0.3 r. In the author's x-ray department 300 to 400 angiographic examinations are performed annually. It therefore became necessary to devise a protective device to minimize the primary radiation received by the surgeon. This device consists of a sheet of lead rubber



3 mm thick (lead equiv. 0.8 mm lead) 82 cm long and 60.6 cm wide. In the center is a lead glass window and at the bottom of the sheet is an oval cut-out space. The protector is counterbalanced from the ceiling and may be lowered over the patient's neck during exposure. Since it is then between the x-ray tube and the surgeon protection is afforded. This is proved by measurements made by a physicist.

Three photographs, 1 drawing, 1 table

STANLEY H MACHT, M D
Baltimore (Md.) City Hospital

Visualization of the Coronary Arteries Preliminary Report. Gunnar Jönsson *Acta radiol* 29 536-540, June 30, 1948

The author presents a preliminary report on roentgenographic visualization of the coronary arteries by the injection of an opaque medium into the aorta through a catheter threaded through the radial artery. In five cases studied by this technique filling of one or both coronary arteries occurred. Several illustrations show the sinus of Valsalva, the semilunar valves, the coronary arteries, and a patent ductus arteriosus. The technique is that used by Radner and others (*Acta radiol* 29 178, 181, 1948; *Absts in Radiology* 52 139 1949).

STANLEY H MACHT, M D
Baltimore (Md.) City Hospital

Peripheral Vascular Disease in the Lungs Roentgenologic Manifestations Robert P. Barden and David A. Cooper *J A M A* 137 584-588 June 12, 1948

The authors have classified conditions affecting the small vessels of the lung in three groups: those in which

there is intrinsic disease of pulmonary vessels; those secondary to pulmonary parenchymal disease; and those resulting from toxic and hypersensitivity states.

Of the first group, arteriosclerosis and arteriolar sclerosis so regularly accompany long standing pulmonary emphysema that they should be assumed as co-existent when there is roentgen evidence of the latter. Obliterative vascular disease should also be suspected in patients without emphysema but with pronounced symptoms of pulmonary insufficiency. An unusual cardiac silhouette is particularly suggestive, as are cor pulmonale results from chronic pulmonary hypertension regardless of cause. Multiple emboli and thrombi obstructing minute pulmonary vessels may occur with leukemias, polycythemia vera, parasitic infestations, metastatic neoplasm, and, in fact, in any condition in which septic, organic or inorganic particles circulate in the blood vessels. Roentgenograms show exaggeration of the pulmonary vascular pattern, with irregular "beading" which may progress to the picture of a symmetric bronchopneumonia.

Pulmonary parenchymal diseases produce obliteration of adjacent blood vessels resulting in delayed healing and eventually in impaired pulmonary function.

Hypersensitivity states cause changes in vessel walls with increased permeability and resultant edema or hemorrhage. Chest films show fluffy shadows, usually extending from each hilus to occupy the inner two thirds of each lung. Occasionally the densities are subpleural in location. Bronchial asthma, eczema, lupus erythematosus, acute rheumatic fever, and periarteritis nodosa are hypersensitive states producing such changes. Exactly similar changes are produced by toxins, whether chemical as in inhalation of irritating gases, bacterial as in epidemic influenza, or metabolic as in terminal stages of glomerulonephritis. It is particularly emphasized that roentgenographic changes produced by hypersensitivity states and toxins are entirely non-specific.

M J SHAPIRO, M D
University of Michigan

Arteriovenous Fistula of the Lung Treated by Ligation of the Pulmonary Artery George B. Packard and James J. Waring *Arch Surg* 56 725-739, June 1948

Cavernous hemangioma of the lung, usually congenital and multiple, represents a peripheral venous-arterial fistula, and the clinical symptoms result from the arteriovenous shunt. Cyanosis, clubbing of the fingers and toes, and polycythemia are always present. A bruit is sometimes heard. Dizziness, dyspnea, fatigue, faintness, and thickening of speech are common and more than half the patients have external capillary hemangiomata on the body. The roentgenographic observations are practically diagnostic. There are one or more irregularly rounded, fairly discrete shadows anywhere in the lung field, usually not over 4 cm in diameter, and with a vascular tail extending toward the lung root. At fluoroscopy, pulsation can usually be seen. Injection of 70 per cent diodrast into the median basilic vein leads to prompt filling of the aneurysm, establishing the diagnosis.

A case is reported here, in which the presence of multiple aneurysms in the right lung was treated by double ligation of the right pulmonary artery. This led to major improvement, although the right lung showed a little loss of aeration as a result of the operation. No bronchspirometric studies had been made, so that the

function of the lung postoperatively had not been determined. Clinical improvement of the patient was maintained over an observation period of three years.

Eight illustrations, including 5 roentgenograms

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Phlebography in the Localization of Incompetent Communicating Veins in Patients with Varicose Veins Theodore B. Massell and Jerome Ettinger. *Ann Surg* 127: 1217-1225, June 1948.

The authors call attention to the high incidence of recurrences of varicose veins in patients who have undergone high saphenous ligation. They recognize the fact that present methods of clinical examination for selection of patients for this procedure are not entirely adequate and have added phlebography as an aid to detecting communicating veins with incompetent valves which could be surgically excised with improvement of the operative results. They describe their phlebographic technique and the operative findings in 20 patients.

Operative findings in their cases are compared with clinical observations by tourniquet tests and also with phlebography. Phlebography has been found to be much more accurate than the clinical tests but there are some false positives and negatives by both methods. Incompetent veins can only be visualized by roentgenographic means when there is good filling of the deep veins with which they are connected. The authors have found it difficult to get a good injection of all three pairs of deep veins in the lower legs. The anterior tibials are the most difficult to visualize and at times the posterior tibial veins are not completely filled. Visualization of the peroneal veins is almost always excellent.

Five roentgenograms, 5 drawings, 2 tables

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

TECHNIC

Amplification of the Fluoroscopic Image by Means of a Thick Dense Clear Crystalline Detector Screen and a Scanning Roentgen-Ray Tube Robert J. Moon. *Am J Roentgenol* 59: 886-888, June 1948.

The author describes his method of amplification of

the fluoroscopic image in essence" as follows: "A scanning roentgen ray tube generates a scanning roentgen ray beam which after passage through the patient falls upon a clear dense crystalline fluorescent screen. Here the roentgen rays produce visible or near-visible light quanta which in turn create a photoelectric current which is amplified and subsequently used to modulate the magnitude of an electron beam current in a kinescope. Since the electron beam in the roentgen-ray tube and the electron beam in the kinescope are both driven by the same sweep circuits a roentgen shadow image will be reconstructed on the kinescope screen."

For a critical consideration of this procedure and of the method suggested by Coltman (*Radiology* 51: 359, 1948) for accomplishing the same end, see the Editorial in *Radiology*, September 1948 (51: 414).

One drawing

Characteristics of Commercial X-Ray Intensifying Screens and Films III and IV Willard W. Van Allen. *Pub Health Rep* 63: 746-748, June 4, 1948, 64: 430-432, April 1, 1949.

The author adds to the series of reports published periodically in Public Health Reports on the characteristics of commercial x-ray intensifying screens and films, with the purpose of keeping this information up to date. In this connection the reader is referred to "Characteristics of X-Ray Films and Screens" by Morgan (*Radiology* 49: 90, 1947) and to a further paper, by Van Allen and Morgan, "Sensitometry of Roentgenographic Films and Screens," to appear in the June issue of *RADIOLOGY*.

Three tables in each paper

Copying X-ray Films David M. Gould, Willard W. Van Allen, and Charles M. Bailey. *Pub Health Rep* 63: 763-765, June 4, 1948.

A method of copying films is described which makes use of the photofluorographic hood and automatic 70 mm camera mounted vertically on a light box. The automatic timer is altered to accommodate the necessarily long exposures.

One photograph

S. F. THOMAS, M.D.
Palo Alto, Calif.

RADIOTHERAPY

Treatment of Cancer of the Maxillary Antrum by Radium Margaret C. Tod. *Brit J Radiol* 21: 270-275, June 1948.

Two hundred and twenty two cases of carcinoma of the maxillary antrum were treated with radium alone. Of these 95 were early and 127 late. Of the patients in the early group, 36 per cent survived five years, and in the late 17 per cent.

The method of treatment was remarkably simple. A single radium source was inserted into the middle of the tumor usually through a Caldwell-Luc approach or sometimes by just pushing the tube through the destroyed bone under intratracheal anesthesia. A dose of 8,000 to 10,000 r in seven to ten days measured at a point 2 cm from the center of the radium source, was used.

Tumors of the mixed salivary type are so radioresistant that they should not be treated by irradiation.

Reticulo endothelial tumors are so radiosensitive that they are better treated with external roentgen therapy.

Seven illustrations, including 4 roentgenograms

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Cancer of the Larynx A Statistical Study LeRoy A. Schall and John J. Ayash. *Ann Otol, Rhin & Laryng* 57: 377-386, June 1948.

This is a report of 418 cases of cancer of the larynx, of which 246 were treated by external irradiation, 158 by surgery alone or surgery with irradiation, and 14 by "radium with other treatment." The irradiation technique has varied over the fifteen-year period covered by this series (1930-45). Earlier cases usually received less than 5,000 r over a period of two or three months. For the past five or six years a total dose of at least 6,000

and more often 7,000 r has been given in four weeks, with additional treatment for extension of the disease and metastases

Though one might expect a higher percentage of cures with the increased dosage the results have been disappointing. The five-year cure rate for 1930-40 was 23 per cent but of 147 patients treated from 1941 to 1945, 70 per cent were already dead at the time of the report. Three per cent had survived five years and 27 per cent for lesser periods.

The site of the lesion and the degree of extension of the disease have been found to be of more importance in the proper choice of treatment than the grading of the tumor. In general, however the results of both surgery and irradiation are better in Grades 1 and 2 than in Grades 3 and 4. When the disease is intrinsic, particularly when it involves the vocal cords or the supraglottic structures, the chances of a cure by external irradiation are best. As the lesion extends beyond the larynx, the prognosis grows definitely worse. It is almost nil when the extension reaches the tongue, and 85 per cent of the authors' patients with node involvement had died.

The laryngeal cancer ideal for thyrotomy or laryngofissure is a localized lesion of the anterior third or the middle of a vocal cord without involvement of the anterior commissure or extension to the vocal process preferably of low grade, and without fixation of the cord. A review of failures with laryngofissure reveals that recurrences have been observed chiefly in those cases in which the cancer had reached the anterior commissure, had crossed to the other cord, or reached the vocal process. Extension of the growth to the anterior tip of the opposite cord is still amenable to laryngofissure by wider dissection. Any fixation or posterior extension to the arytenoid, even without fixation, contraindicates laryngofissure.

When external irradiation fails to control the disease, surgery can still be done, although the healing may be delayed. In this series laryngofissure was done in four cases and laryngectomy in eight after external irradiation failed to control the disease.

Summarizing their observations, the authors state: "Limited lesions of grades 3 and 4 are best treated by surgery followed by postoperative external irradiation."

"Early unfixed cordal lesions are 46 per cent radio-curable by concentrated external irradiation. With the extension of the disease to the subglottic space and with cord fixation, laryngectomy is the treatment of choice and not external irradiation. Patients with borderline cases cases which some observers call extrinsic, can be successfully treated by surgery and irradiation."

"In a group of poorly selected cases five year cures were obtained by laryngofissure in 58 per cent. Total laryngectomy on a series of patients operated on between 1930 and 1940 and therefore followed over five years, resulted in a 64 per cent survival."

It is further concluded that, in the hopeless case of cancer of the larynx, external irradiation is not palliative and often hastens death. Regression of the lesion does not signify a cure, the patient must be kept under close observation for at least five years. The so called trial period of irradiation is a fallacy. A full curative dose of external irradiation is necessary to determine radiosensitivity.

Ten tables

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Prognostic Significance of Early Diagnosis in Breast Cancer. A Study of the Early Symptoms and Their Duration Before the Patients Come Under Treatment. Sigvard Kaae. *Acta radiol* 29 475-492, June 30 1948.

The author presents an analysis of 500 consecutive cases of breast cancer and Paget's disease of the nipple from the Radium Center in Copenhagen. All but 5 cases were in females. Forty-three patients had had radical operation elsewhere and were referred for post-operative roentgen therapy, the others had received no treatment except for biopsy or local tumor extirpation in some cases.

The first sign was a nodule in the breast in 74 per cent of the cases, painful sensations in the breast, axilla, or arm in 12 per cent of cases, retraction of the nipple in 4.2 per cent, discharge from the nipple in 2.7 per cent, axillary lymph node in 2.5 per cent, and ulceration in the breast in 1.7 per cent. One-third of the patients consulted a physician within a week of their observation of the first signs, one-half within a month, two-thirds within three months and 77 per cent within six months.

The length of time from the first medical examination to the institution of adequate treatment was one week or less in 59 per cent of cases, one month or less in 78 per cent, three months or less in 86 per cent, six months or less in 91 per cent and one year or less in 95 per cent.

To show the importance of early diagnosis and treatment, the author found that all the cases which came under treatment within two weeks were technically operable. The operability rate dropped to 71 per cent when the delay in treatment was one year.

Seven tables

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Introduction to Symposium on Cancer of the Esophagus and Gastric Cardia. George T. Pack. *Surgery* 23 867-873, June 1948.

In this paper introducing a symposium on cancer of the esophagus and gastric cardia, Pack gives a brief review of the results of surgical and radiation therapy in these cases, with some of the reasons for the generally pessimistic attitude of the profession. The latter include late diagnosis, perforation, high grade of malignancy, poor general condition by the time the diagnosis is made, infrequent use of esophagoscopy, frequency of coexistent pulmonary or cardiac disease in the age group in which these tumors occur. Failure of radium therapy is attributed to the difficulty of obtaining adequate distribution of the dose and of reaching distant sites of extension, and to necrosis and sloughing of the infected tumor.

Roentgen therapy has been followed by good palliative results and Nielsen is quoted to the effect that, at least to Scandinavian radiologists, "there is no doubt that the difficult task of trying to treat esophageal cancer both radically and symptomatically will to a very great extent continue to be the domain of radiotherapy." Nielsen's work with rotation roentgen therapy is described (see *Absts. in Radiology* 40 114, 1943, 47 100, 1946).

The other papers in the Symposium are chiefly of surgical interest. One, by Sherman, on diagnosis is abstracted elsewhere in this issue of *Radiology* (p 756).

Three photographs, 1 drawing

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Dosage Measurements for Various Methods of Intrauterine Radium Applications in Cancer of the Endometrium. James F Nolan and William Natoli. *Am J Roentgenol* 59 786-795, June 1948

By means of a phantom and suitable film the authors plotted isodose curves for radiation therapy of endometrial cancer by six different techniques. The techniques were (1) short tandem, (2) long tandem, (3) 'Y' applicator (tandem same as in (1) plus 2 large capsules in the cornea), (4) long tandem, as in (2) plus 2 small capsules in the cornua, (5) 7 large capsules, (6) 13 small capsules.

The film was placed between the layers of the phantom, and the density of the blackness was measured with a densitometer to determine the various dosages.

Isodose curves are presented for each technic, showing a definite improvement in the uniformity of distribution as the number of sources was increased, the 13 small capsules giving the most uniform field. In this experiment the cavity remained constant in size and shape.

More uniform radiation will allow higher milligram-hour values because of the elimination of hot spots, and should therefore result in better tumor control.

Nine figures, 2 tables. ZAC F ENDRESS, M D
Pontiac, Mich

Sarcoma of the Uterus. Report of Eighteen Cases. Thomas Perry, Jr. *New England J Med* 238 793-799, June 3, 1948

This is a report of 18 cases of uterine sarcoma from the Rhode Island Hospital occurring in the last eighteen years. This type of growth is uncommon. Of the 18 cases, 7 were leiomyosarcoma, 4 mixed mesodermal sarcoma, 3 carcinosarcoma, 2 giant-cell sarcoma, 1 stromal-cell sarcoma, and 1 botryoid sarcoma, this last in an infant of five and a half months. Panhysterectomy with bilateral salpingo-oophorectomy is considered to be the treatment of choice. Irradiation seems to have no effect on the tumors.

Several case reports are presented. One patient had been given 1,000 mg hr of radium to the uterus in September 1924, for menopausal bleeding. In December 1934, a complete hysterectomy was done, showing a mixed mesodermal tumor of the uterus. Another patient had received 1,400 mg hr of radium for menopausal bleeding in January 1937. In May 1943, the uterus was found enlarged and a hysterectomy showed carcinosarcoma. This patient had a recurrence and x-ray therapy was without influence on the growth.

One roentgenogram, 9 photomicrographs, 2 tables.
JOHN B MCANENY, M D
Johnstown, Penna

Granulosa-Cell Tumor of the Ovary, with Special Reference to Radiosensitivity. Robert D Moreton and Eugene T Leddy. *Am J Roentgenol* 59 717-726, May 1948

This article is concerned chiefly with the radiosensitivity of granulosa-cell tumors. It includes a considerable review of the literature.

Of 50 cases of granulosa-cell tumor seen at the Mayo Clinic 11 received radiation therapy. Six patients were alive at the time of the report, 1 for one year and the remaining 5 more than nine years. No comparison is made between the survival rates of this group and the 39 cases which did not receive radiation therapy.

The authors state "From a review of the literature it is difficult to draw conclusions about the radiosensitivity of granulosa-cell tumors." They do not clear up the difficulty.

One table, isodose curves. G K VOLLMAR, M D
The Henry Ford Hospital

Treatment of Carcinoma of the Prostate with Radium. Raymond Darget. *Urol & Cutan Rev* 52 352-357, June 1948

High hopes were entertained for the therapeutic effectiveness of hormones and orchiectomy for carcinoma of the prostate. These have not, however, been fully realized and there has been some return to the older methods of prostatectomy and radium application. These methods, it is felt, can be used as a supplement to hormonal treatment and orchiectomy.

The author uses radium, which may be applied through a transvesical approach, through a perineal incision, or with a radium holder catheter.

Forty-seven cases were treated, in 21 of which it would have been impossible to do any form of prostatectomy. In 20 cases perineal implantation was done, in 3, transvesical and perineal implantation, in 3, transvesical implantation alone, in 11, a radium holder catheter was used, and in 1 treatment was by perineal implantation and radium holder catheter. Eighteen patients were alive at the time of the report, one of these had survived five years. Radium was not used in suspected or proved cases of metastasis.

Eleven illustrations, including 6 roentgenograms.

MAURICE D SACHS, M D
Cleveland, Ohio

Intensive Radium Therapy with Beta Rays. Paul de Plaen. *J deradiol et d'électrol* 29 264-267 1948 (In French)

This paper is of interest to American radiologists on two counts. (1) It reviews the early experimental work on the local action of beta rays. (2) The authors have used the 50 mg, 0.3 mm monel-wall Crowe nasopharyngeal applicator for the treatment of cancers of the skin, lip, urethra vulva, etc. The paper describes the physical characteristics of the applicator and the tissue doses thereby obtained, which should serve to emphasize to American radiologists and otolaryngologists the hazards both to themselves and patients, inherent in careless use of so potent a source of caustic radiation.

Four photographs, 5 tables.

SIMMON T CANTRIL, M D
Seattle, Wash

RADIOACTIVE ISOTOPES

Spontaneous and Experimentally Induced Uptake of Radioactive Iodine in Metastases from Thyroid Carcinoma. A Preliminary Report. S M Seidlin, E Oshry, and A A Yalow. *J Clin Endocrinol* 8 423-432, June 1948

Fourteen unselected cases of metastatic thyroid carcinoma were studied with orally administered radioactive iodine (I^{131}) at the Montefiore Hospital, New York up to June 1947. Tracer doses ranged from 500 to 2,000 microcuries. Urine was collected for at least the first forty-eight hours and the radioactive iodine content estimated. Forty-eight hours after the dose was administered, *in vivo* readings were taken with a Geiger Müller counter to determine the degree of

localization of the isotope in the thyroid gland and the metastases

Five of the 14 cases showed uptake in at least one metastatic lesion the first time radioiodine was administered. Subsequently, radioautographs were made from tissue from 6 of the 14 patients. In all of these, the autographs showed definite concentration of radioactive iodine in the metastatic tissue, in one, measurements had not indicated uptake, showing that the radioautographic technic, when feasible, is more sensitive than external measurements. In all 5 "positive" cases a complete or nearly complete thyroidectomy, or a subtotal thyroidectomy had previously been done, fol-

lowed by x-ray treatment. However, not all patients who had had partial thyroidectomy and irradiation showed radioiodine uptake by metastases.

The radioiodine uptake by the metastatic carcinoma was found to be more closely correlated to the degree of preceding thyroidectomy than to the histologic structure or "type" of the tissue.

It is concluded that, in cases in which initial studies with radioiodine do not show concentration in the metastases, such concentration may be induced by either thyroidectomy (surgical, radiation or chemical) or injections of thyrotropic hormone.

Eleven illustrations

RADIATION INJURIES

Cancer of the Corpus Uteri Following Radiation Therapy for Benign Uterine Lesions Frank R. Smith and Lemuel Bowden. *Am J Roentgenol* 59:796-804, June 1948

An attempt was made to determine a possible relationship between the cancer of the uterus which developed in 8 patients and the radiation therapy they had previously received for various benign lesions. These 8 cases were seen during a twenty-year period, when 946 patients with cancer of the corpus uteri were admitted. Thirty nine had had previous radiation therapy (exclusive of those who received irradiation for the cancer itself and were referred merely for continuation of treatment), but only 8 met the following criteria: (1) negative endometrial biopsy at the time of the irradiation for a benign lesion, (2) an interval of ten years or more between the initial irradiation and the onset of symptoms of cancer.

Two factors prevented a definite conclusion from being reached: (1) the prevalence of cancer of the corpus uteri in the general population is not known, (2) 100 per cent follow up was not obtained so that perhaps more than 8 cases occurred.

Four tables

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Lesions of the Urinary Tract Following Radiotherapy for Carcinoma of the Cervix Uteri T. J. D. Lane. *Brit J Urol* 20:67-71, June 1948

The literature on injuries of the urinary tract following irradiation for the treatment of carcinoma of the cervix is reviewed and 2 cases with vesical lesions are presented. In these cases excellent hemostatic effects were obtained with solid silver nitrate in the form of a small bead on the end of a thin wooden rod passed through a Braasch direct cystoscope.

Reconstruction Following Irradiation Injuries Paul W. Greeley. *Arch Surg* 56:741-748, June 1948

The author discusses generally the well known changes following excessive irradiation as seen in the superficial tissues. He states: "In spite of enthusiastic reports given by the advocates of local applications of radon paste or the aloe vera leaf I have apparently seen only those patients that did not respond to such simple management. Since the pathologic reaction is progressive and irreversible, I feel that a permanent cure can be anticipated only when all of the damaged tissue has been excised back to an area of good blood supply. If this excision is not wide enough further re-

constructive operations will fail and later degeneration may occur around or below the site of the original excision." After a radical excision, the problem of closure is solved occasionally by undermining and direct suture, more often by some type of skin grafting operation.

Sixteen illustrations
LEWIS G. JACOBS, M.D.
Oakland, Calif.

Roentgen-Ray Calibration of Photographic Film Exposure Meter L. J. Deal, J. H. Roberson, and F. H. Day. *Am J Roentgenol* 59:731-736, May 1948

This is a report of the use and calibration of a 2 film packet for determination of stray radiation. The emulsion of one film is sensitive to high-voltage (gamma) radiation, the other is relatively insensitive. In addition one-half of the packet is covered by 1 mm of cadmium, the other half by only the wrapper.

Numerous calibration curves are presented showing film densities for various voltages for the sensitive and insensitive emulsions and for the shielded and unshielded portions. Little difference was noted above potentials of 400 kv. Below this figure, the densities varied considerably under the different conditions. At the lower voltages considerable care must be exercised in ascertaining the portion of the potential region to which the film was exposed if this type of reading alone is used to determine exposure.

Five charts, 1 table
G. K. VOLLMAR, M.D.
The Henry Ford Hospital

Human Pathologic Anatomy of Ionizing Radiation Effects of the Atomic Bomb Explosions Elbert DeCoursey. *Mil Surgeon* 102:427-432, June 1948

The author discusses the necropsy findings from about 260 Japanese dying as a result of irradiation at Nagasaki and Hiroshima. The material represents the work of many investigators, both American and Japanese.

Mainly the lymphoid and hematopoietic tissues, skin, genital organs and gastro-intestinal tract were affected. There was atrophy of lymphoid elements in lymph nodes, tonsils, spleen and gastro-intestinal tract. Early there was atrophy of the bone marrow, which either continued or was followed by focal or diffuse hyperplasia with maturation arrest. Necrotizing inflammation of the oropharynx was prominent but limited to the third to sixth week. The scalp showed the surest external gross sign of ionization—alopecia. This with hemorrhagic lesions appeared about the same time as the throat lesions.

The testes showed prominent microscopic changes, almost all the sex cells being destroyed. The ovaries showed very little more than scarcity of proliferating follicles. The intestinal mucosa mainly of the distal

colon, was the site of changes which varied from ulcerated hemorrhagic foci to focal or widespread necrosis and ulceration with formation of diphtheritic membranes.

EXPERIMENTAL STUDIES

The Effect of Beta Rays on Cells Cultivated in Vitro
Ilse Lasnitzki Brit J Radiol 21 265-269 June 1948

Avian fibroblasts were irradiated with beta rays at 244, 200 and 74 r/mm, with a total dose of 1,000 r. Following irradiation there was a sharp fall in mitosis and the rapid development of abnormal mitotic figures and degenerating cells. The effects were qualitatively similar to those seen with x rays and gamma rays, but the latent period was shorter and recovery more prompt.

Three graphs, 3 tables

SYDNEY J HAWLEY, M D
Seattle Wash

Effect of Low Dosage Roentgen Radiation on the Gonadotropic Function of the Hypophysis of the Mature and Immature Female Albino Rat John H. Freed, Edmond J. Farris, Douglas P. Murphy, and Eugene P. Pendergrass J Clin Endocrinol 8 461-481, June 1948

In view of the wide interest and frequent use of low-dosage roentgen irradiation in the treatment of functional endocrine dyscrasias and the many controversial theories concerning its effect on glandular function, the authors thought it important to study the action of radiation on the normal pituitary of the experimental animal as manifested in its sexual system.

Five sexually mature female Wistar albino rats were given single doses of roentgen radiation to the pituitary, varying from 100 to 200 r, at 7:30 A.M. on the third day of their estrus cycles and none appeared to be affected by treatment.

Fifty-seven sexually mature female Wistar albino rats were given single or multiple doses of roentgen radiation to the pituitary varying from 5 to 300 r, at 7:30 A.M. on the second day of their estrus cycles. Twenty-eight additional rats were used as controls. Physiological signs of heat, ear quivering, and copulation response were observed in 28 of the 57 rats from one to two hours following treatment. These signs of heat lasted for six to eight hours. Fifteen of these 28 rats accepted the male, 4 pregnancies and one pseudo-pregnancy resulted. No change was noted in the running activity or periodicity of the estrus cycle of the treated rats. Gross anatomical studies and weight determinations were made of the pituitaries, ovaries and uteri of 6 of the treated rats who showed an ear quivering-copulation response as well as the 7 controls. The pituitary weights of the treated rats appeared to be significantly greater than those of the controls. The ovarian weights were similar in the two groups. The uterine weights of the treated rats were slightly greater than those of the controls, but this increase was not nearly so definite as that noted in rats during normal estrus.

Sixteen immature female Wistar albino rats were given either a single or five successive daily roentgen

treatments to the pituitary with doses varying from 5 to 100 r per treatment. Six additional rats were used as controls. Eight of the immature treated rats were followed until vaginal opening occurred at ages ranging from fifty-three to sixty-five days. This is within the normal limits of age for the onset of sexual maturity.

Eight additional immature treated animals and 4 controls were sacrificed twelve days after irradiation of the pituitary, and pituitary, ovarian, and uterine weight determinations were made. Grossly the appearance and weight of the organs from the treated immature rats were in no way different from their controls.

As a result of these studies, the following conclusions were reached: (1) Low-dosage pituitary irradiation can produce a transient effect on the normal pituitary function of the rat. Though the immediate physiological effect is in the nature of a stimulus, such an effect is only transient and not prolonged. (2) Irradiation of the pituitary in small doses has no effect on the normal development of the sexual system of immature twenty-eight day old female rats. (3) There is no evidence that x rays can stimulate living cells if by stimulation is meant a continued acceleration of their normal growth or function. (4) Irradiation of the pituitary in small doses has no evident harmful effect in the experimental rat.

Two charts, 6 tables

Absorption and Metabolism of Lipiodol After Oral Administration. Method for the Study of Fat Absorption and Fat Metabolism in Man J. Groen Am J Med 4 814-826 June 1948

The author studied the absorption of lipiodol by means of x rays and determined the excretion of the iodine in urine and feces as a test of fat absorption in man. At 7:30 A.M. the patient having been tested for hypersensitivity to iodine received a breakfast of two biscuits and 300 c.c. of tea. At the same time a mixture was given of 10 c.c. Lipiodol Lafay and 10 c.c. olive oil. This quantity contained 4.2 gm. of iodine (according to the manufacturers it should contain 5.4 gm. of iodine). Between 7:30 and 12 no food was taken and no drugs were administered. It was found that a satisfactory picture of the course of absorption could be obtained by taking films at two, three and one half, five, eight, and ten hours after administration of the contrast medium. When fat absorption is impaired, a considerable part of the contrast material remains visible in the films, it escapes absorption in the small intestine and may produce a contrast picture of the colon. Urine and feces were collected for twelve days and the iodine content was determined.

Normal absorption of lipiodol was found in achlorhydria, duodenal ulcer, uncomplicated cholelithiasis, peritoneal tuberculosis, obesity, and anorexia nervosa.

Diminished fat absorption was demonstrated in sprue, obstructive jaundice, intestinal tuberculosis, severe ulcerative colitis, gastrojejunocolic fistula, pan-

creatic insufficiency, in some cases of pernicious anemia and sometimes after stomach operation. The impaired absorption in non-tropical sprue improved but did not become completely normal after treatment with diet and liver extract.

The disadvantages of the method are its cost and the fact that it cannot be carried out in patients who are hypersensitive to iodine or who are severely ill.

The "fat relief picture" was not compared with that obtained with a barium meal. Roentgenograms are reproduced.

Effect of X-Rays on the Lymphatic Nodule, with Reference to the Dose and Relative Sensitivities of Different Species. P. P. H. De Bruyn. *Anat Rec* 101:373-405, July 1948.

Experimental studies carried out by the author show that the extent of histologic damage found in the lymph nodes of animals exposed to x-rays is correlated with the dosage given. This relationship is seen in the amount of nuclear debris resulting from the destruction of lymphocytes, but is more strikingly evident in the destructive and regenerative changes in the nodules of the lymph nodes and intestinal lymphatic tissue.

Rabbits, rats, and guinea-pigs were irradiated with x-rays, 200 kv p, filtered with 0.5 mm of copper and 1.0 mm of aluminum. The dose rate varied from 11 r/min to 16 r/min. The animals were killed in pairs at varying intervals after irradiation. The mesenteric lymph nodes, patches of Peyer, and, in the rabbit the appendix as well, were fixed in Zenker-formol, embedded in celloidin and stained with hematoxylin-eosin-azure II. The measure of lethal sensitivity to x-rays employed was the dose which kills 50 per cent of the animals within thirty days (L.D. 50/30 days).

Under the conditions of the experiments, the following changes occurred in the lymphatic nodules: (a) In rabbits, doses of 800 r and 600 r completely destroyed the great majority of the nodules, resulting in a "nodule-free" period until about three weeks after treatment, at which time new nodules began to form. After 400 r the majority of the nodules were only partially destroyed.

These regenerated rapidly and at five days were normal in appearance. A dose of 100 r did not produce a marked change in the majority of the nodules. Judging from the amount of debris, 50 r is the lowest dose which produces histologically detectable changes. (b) In rats doses of 600 r and 400 r produced changes identical to those observed in rabbits at these doses. (c) In guinea-pigs, a dose of 175 r produced changes comparable to those in rabbits and rats after 400 r or less.

Since the L.D. 50/30 days of x-rays for rabbit, rat, and guinea-pig are 800 r, 600 r, and 175 r, respectively, it appears that the intensity of damage to the lymph node in these species is related to absolute dosage and is independent of the L.D. 50/30 days of these species.

Evidence obtained from the regeneration of the lymphatic nodules after their elimination by irradiation indicates that one of the phases in the cyclic changes in the nodules is of a proliferative character, notwithstanding the presence of signs of cell death.

Twenty-five photomicrographs.

Distribution of Radioactivity in the Mouse Following Administration of Dibenzanthracene Labeled in the 9 and 10 Positions with Carbon 14. Charles Heidelberger and Hardin B. Jones. *Cancer* 1:252-260, July 1948.

Dibenzanthracene, labeled in the 9 and 10 positions with C_{14} , was administered to mice intravenously and by stomach tube as an aqueous colloid, and intraperitoneally, subcutaneously, and by stomach tube in tricaprylin solution. The distribution of radioactivity in the mice was then determined at various time intervals after administration of the carcinogen.

It was found that the radioactive substances are rapidly eliminated, largely through the feces, and ordinarily very little material is absorbed. The distribution and rate of elimination depend upon the mode of administration.

There is an appreciable quantity of radioactivity in tumors produced several months after a single subcutaneous injection of dibenzanthracene.

There appear to be no detectable effects from the irradiation of the labeled carcinogen.

Seven tables, 3 charts.

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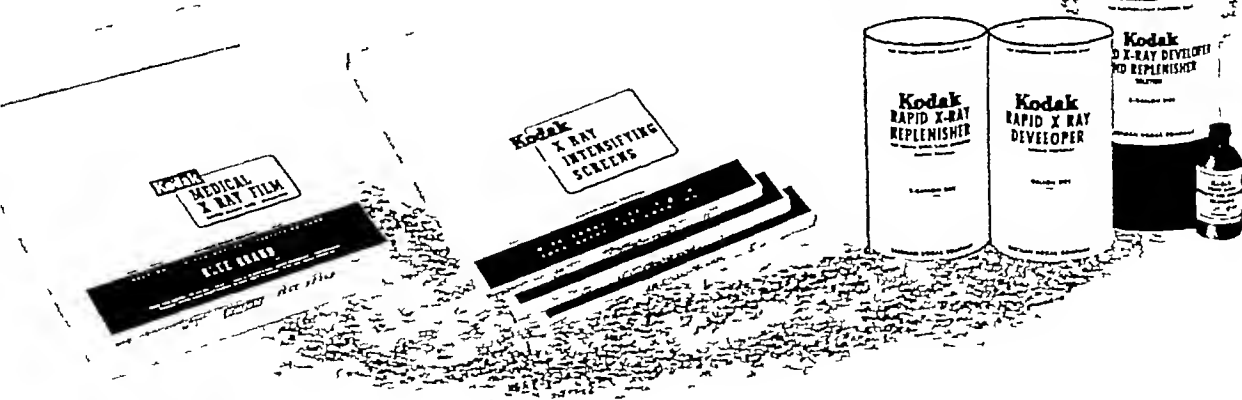
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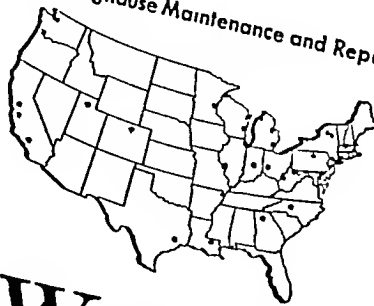
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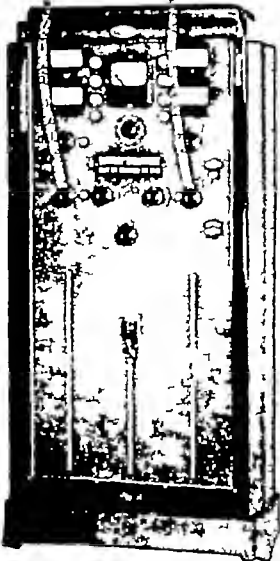
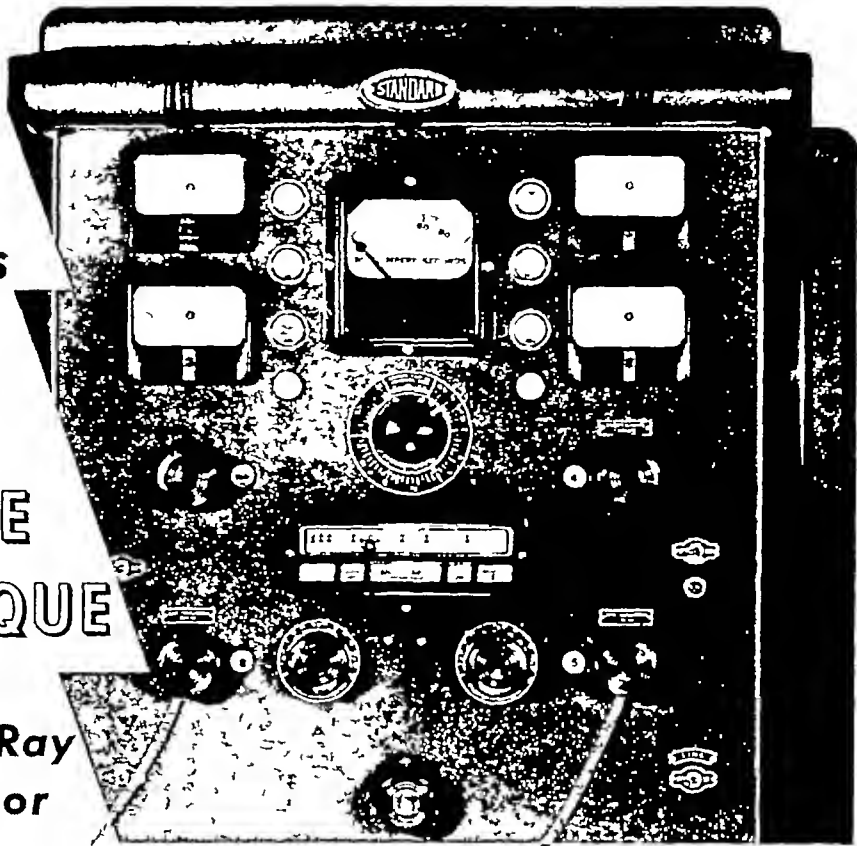
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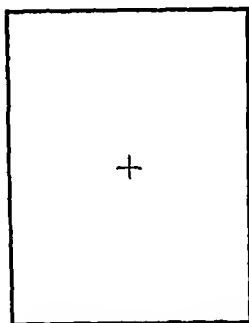
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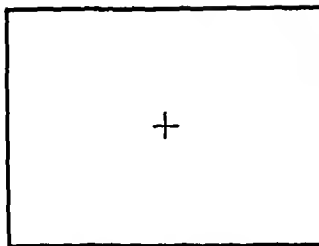


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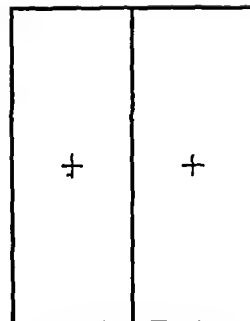
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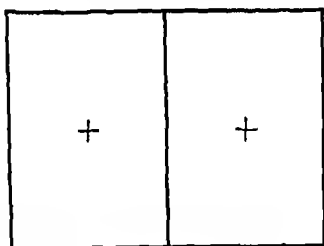
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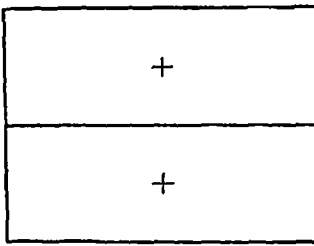
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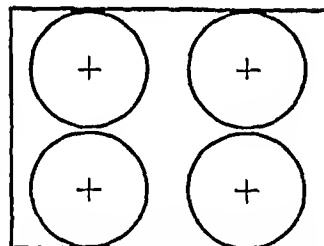
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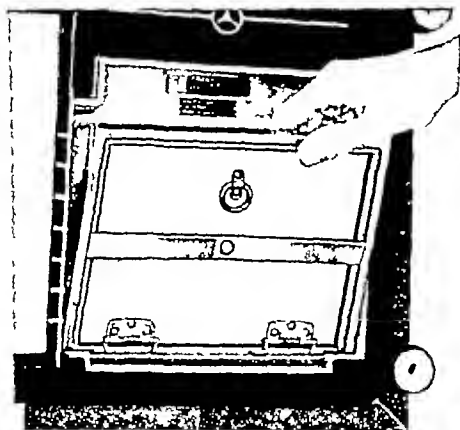
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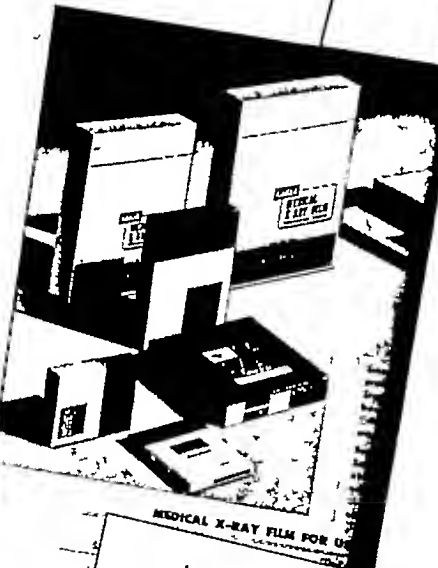
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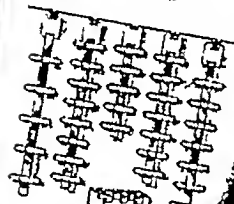
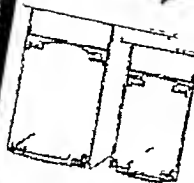
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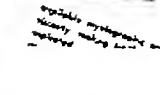
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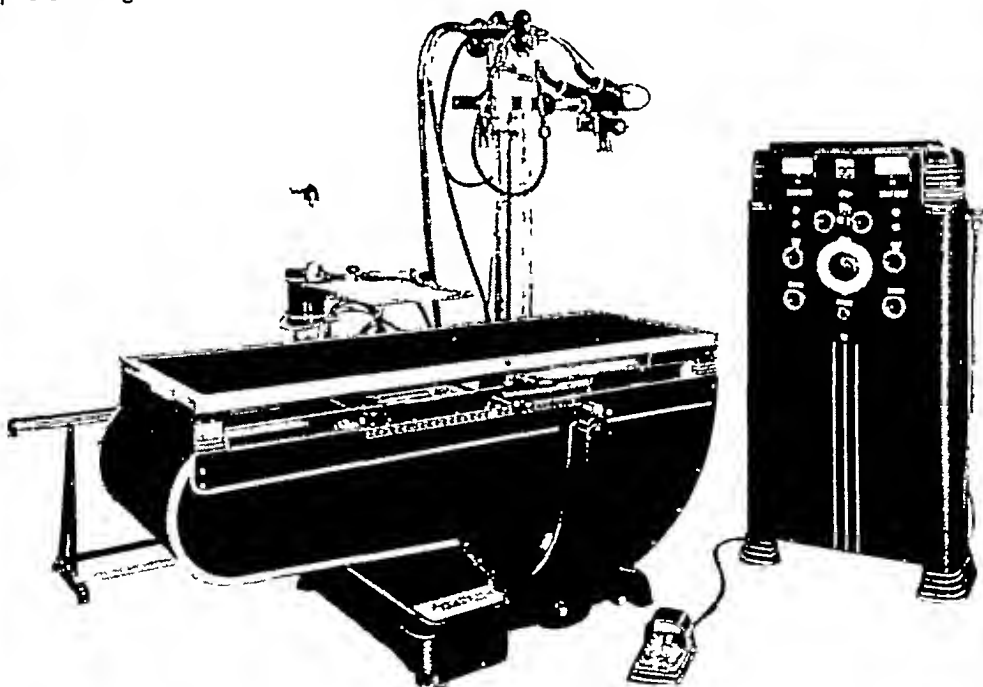
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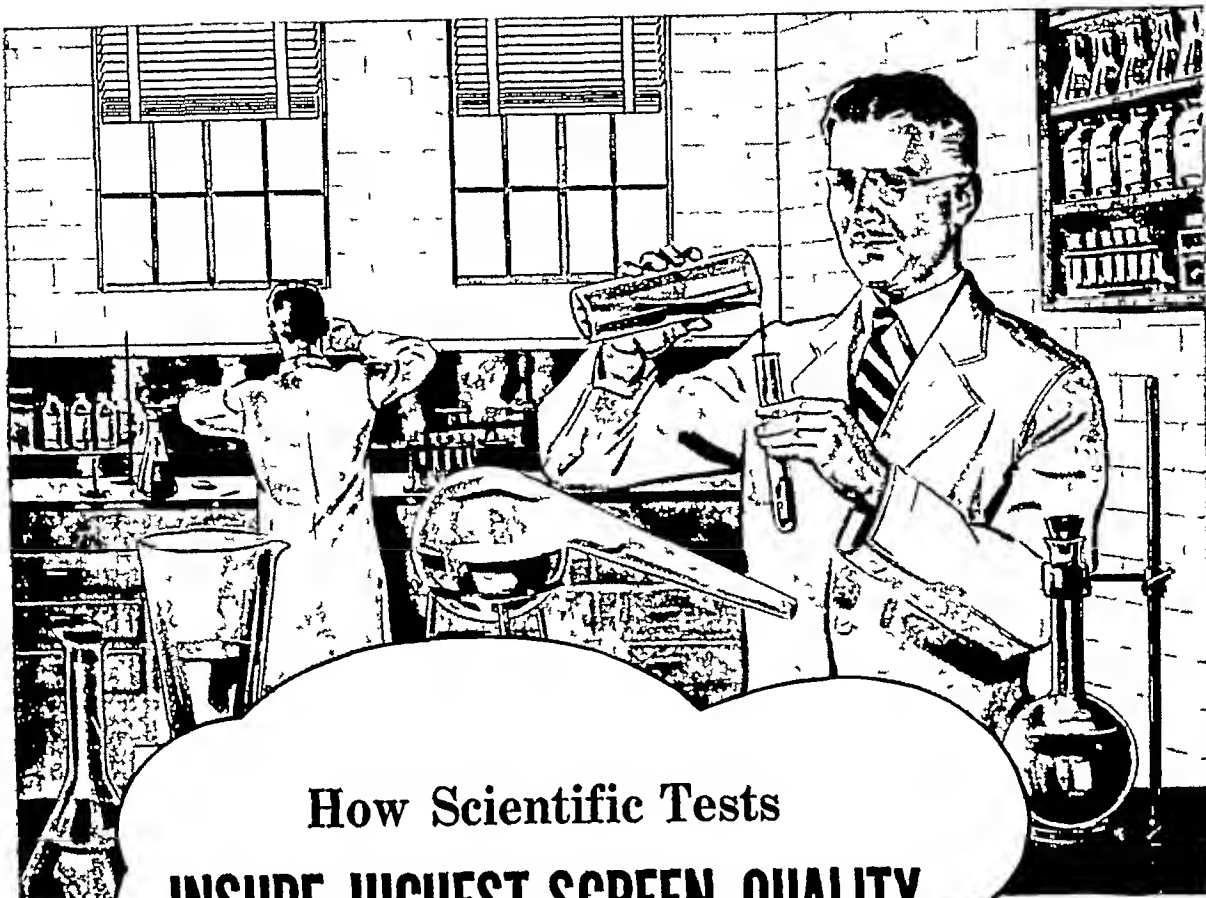


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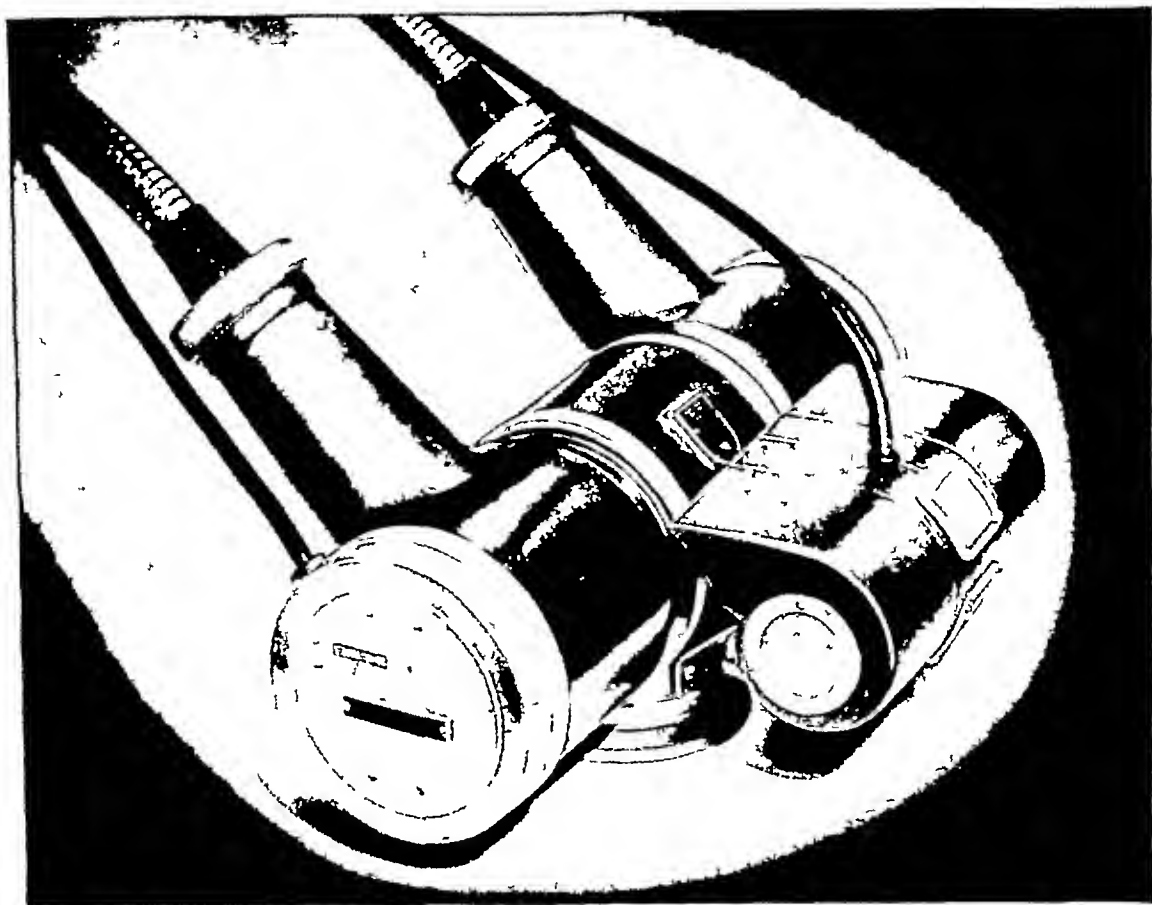
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LITERATURE

Beneficial Effects in use of
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- 1) General Practice Clinics
Radiology Section
Volume 4 - No 4 - October 1947
Volume 4 - No 2 - April 1947
 - 2) Medical Journal Record
Publishing Co, Inc.
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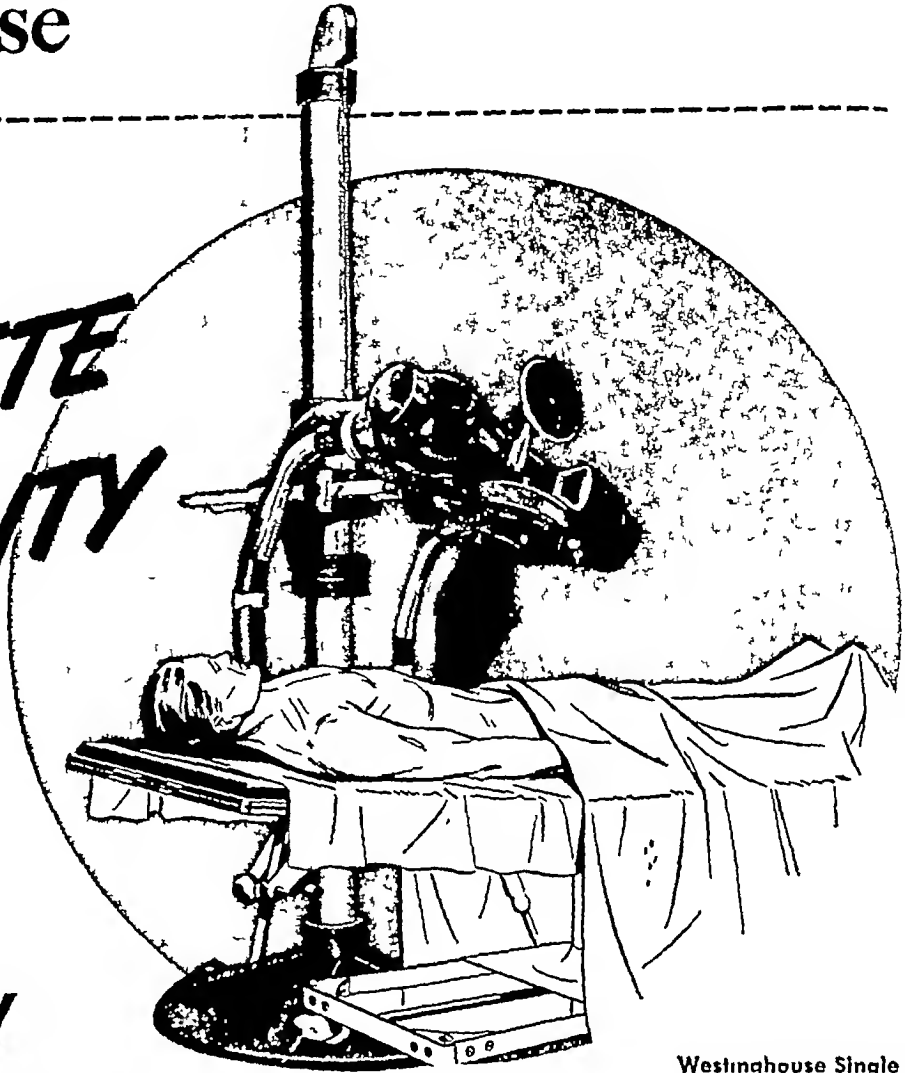
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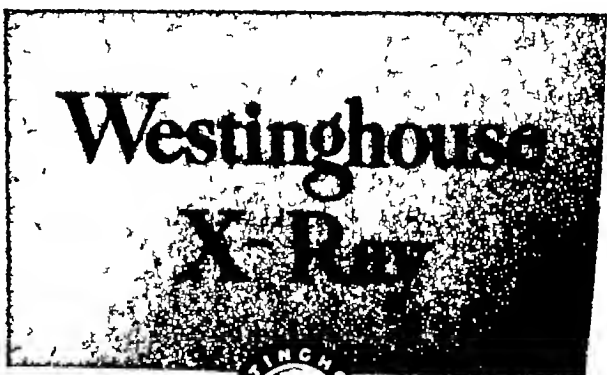
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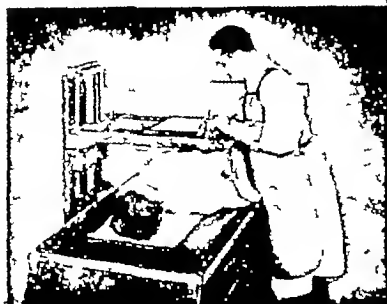
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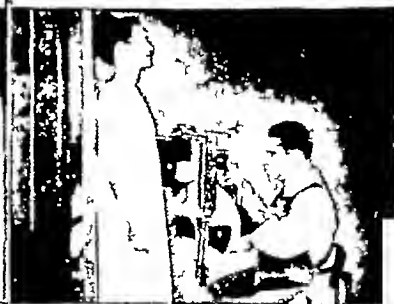
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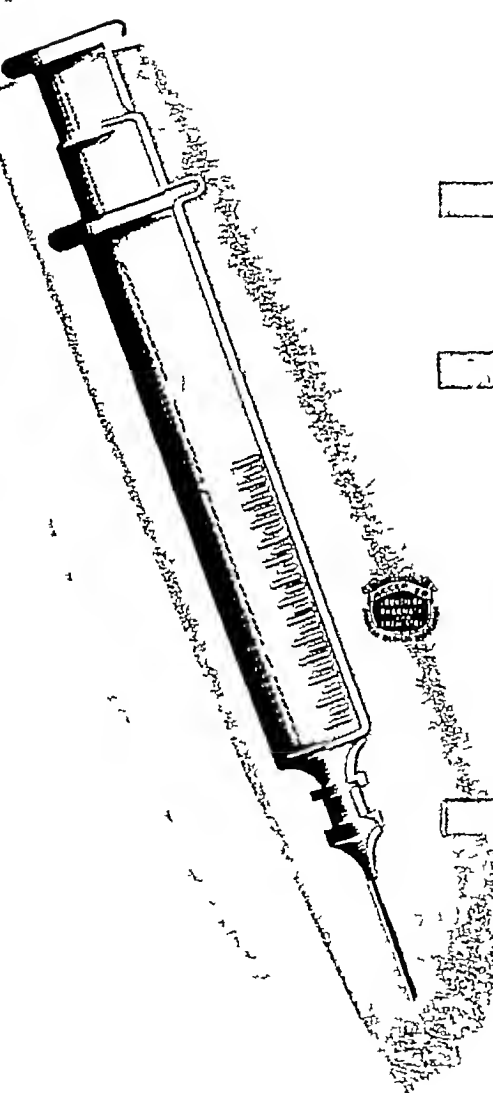


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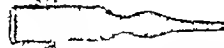
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BIBLIOGRAPHY: 1 Simon S : J.A.M.A 138 127 1948.
2 Pearman R O : New England J Med 228:507 1943 3 Kearns W M.,
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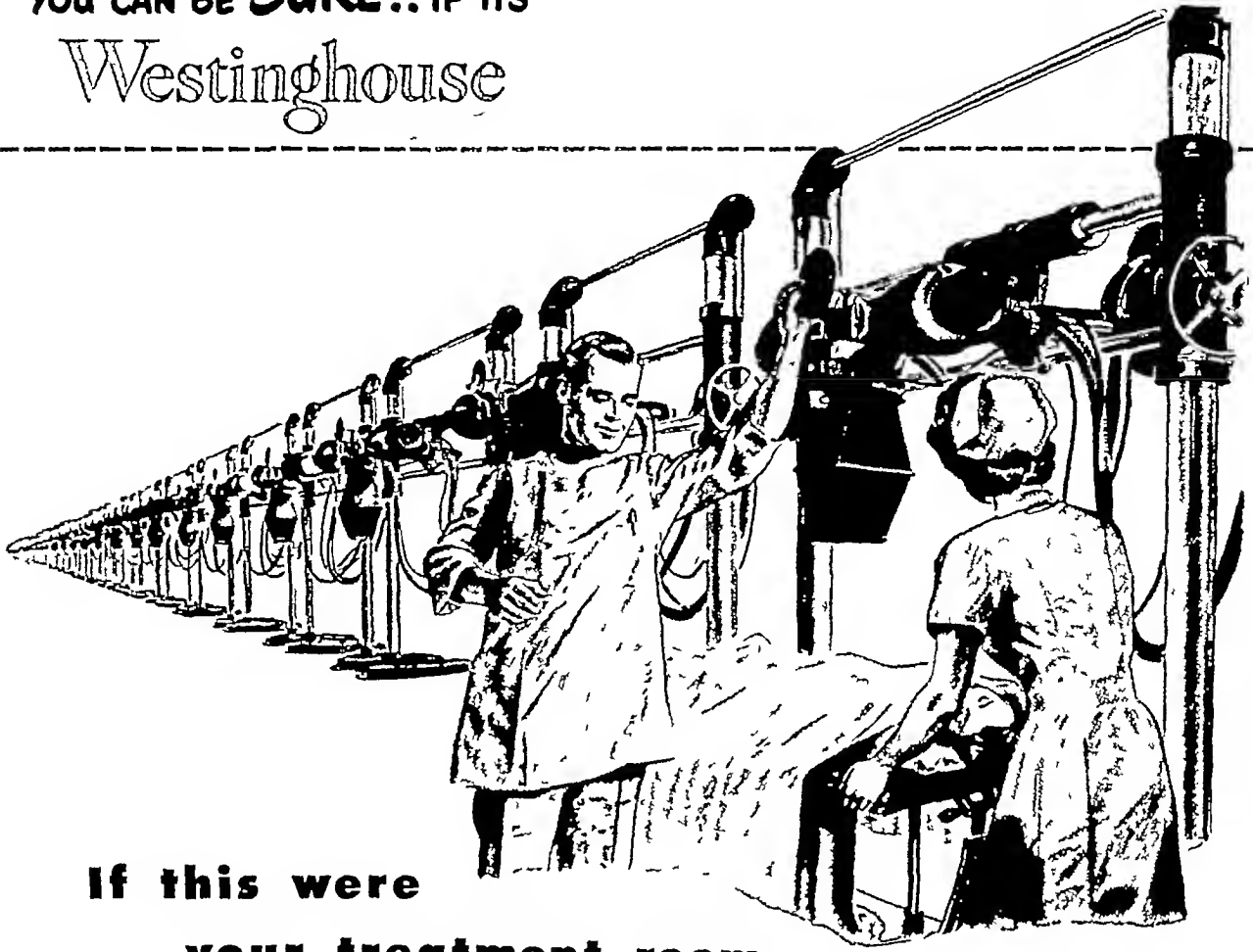
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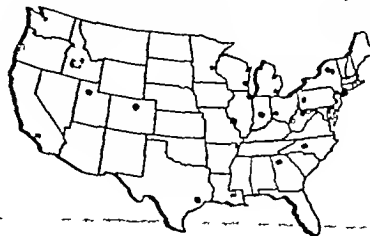
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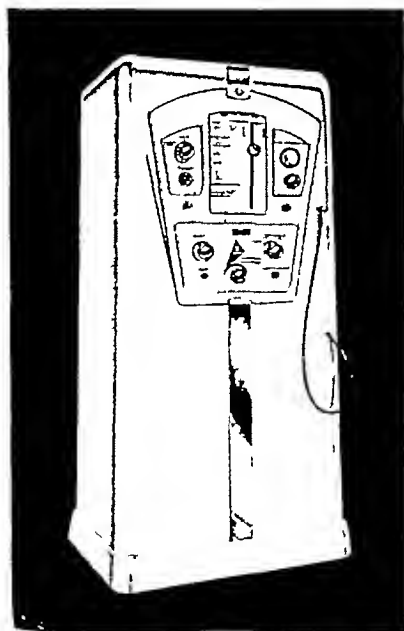
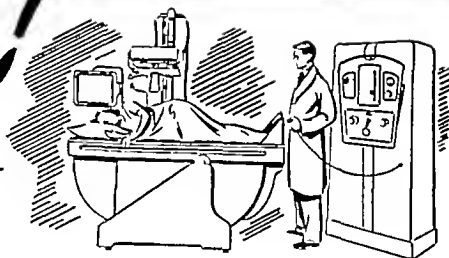
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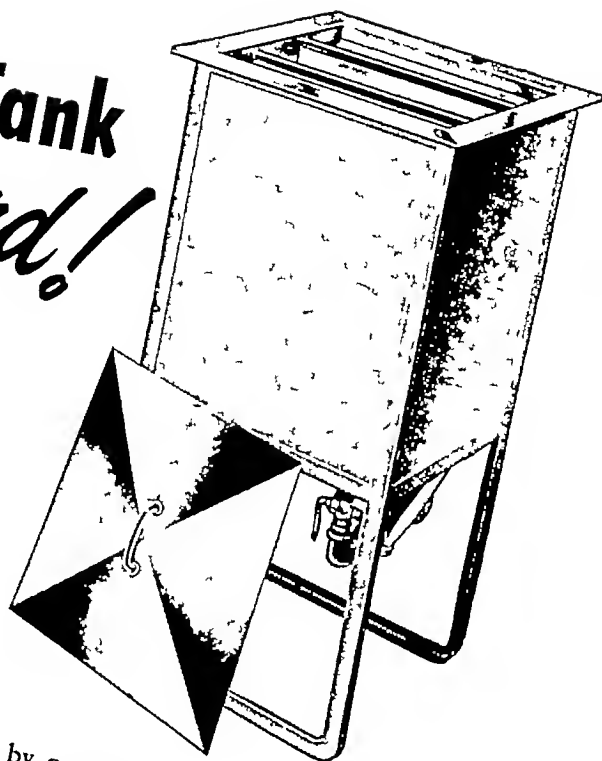


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RADIOLOGY

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Vol 52

JUNE 1949

No 6

Peptic Ulcer The Importance of Films in Diagnosis¹

FREDERIC E. TEMPLETON, M.D.

Seattle, Wash.

IT IS THE PURPOSE of this report to emphasize the important role played by roentgenologic films in identifying gastro-intestinal lesions, particularly gastric and duodenal ulcer. A high percentage of physicians share the opinion that the diagnosis of gastro-intestinal disease is based largely on fluoroscopic findings and that films, unless interpreted in the light of such findings, are usually meaningless. Fluoroscopy, by the simplicity of the apparatus and procedure and by its high diagnostic accuracy in proper hands, has discouraged interest in the potentialities of films. Emphasis on finding early lesions, particularly cancer, and on the potential dangers of excessive exposure to radiation is directing investigators to re-explore the possibility of using more films and less fluoroscopy.

The present situation is comparable to that of diseases of the chest and is stimulated by recent technical developments in the study of those diseases. Most lesions of the lungs are seen at fluoroscopy, but a certain percentage escape observation even by the experienced examiner. With routine use of films, even of the miniature variety, the number of pulmonary lesions overlooked has decreased. A similar situation holds for the gastro-intestinal tract,

except for the use of miniature films, whose potentialities are now being explored. Most lesions can be seen at fluoroscopy, since most of them are large—in the order of a centimeter in diameter or more. It is in the smaller ones that films give the greatest aid. But even so, one is amazed at the apparent large size of certain lesions that escape detection under the fluoroscope. While this embarrassing situation is infrequent, it occurs often enough to cause one to speculate on the cause. Overwork and fatigue with the accompanying divided attention, failure to follow a set routine, and a combination of certain physical and physiologic phenomena, preventing clear images, are responsible for failures. Films play a valuable role in examination of the heavy patient in whom the fluoroscopic image is dim and will continue to play this role until amplification of the fluoroscopic image is a reality.

The gastro-intestinal tract is a pliable organ, capable of self motion. The contours are varied by contractions of the muscles and by extraneous influences, such as pressure on the abdominal wall. Since the appearance of the stomach and the duodenum varies from moment to moment, fluoroscopy is invaluable in studying the constantly changing pattern and to dif-

¹ From the Department of Radiology, University of Washington School of Medicine. Presented as part of a Symposium on Peptic Ulcer at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec 5-10, 1948.

ferentiate the normal from the abnormal. Witness, for example, the rigidity of the walls with the obliteration of peristalsis produced by neoplasm. However, with a few exceptions, somewhere in the cycle of motion or under the influence of pressure or with certain positions, there appear one or two anatomic patterns which impart the story. In most instances, these significant patterns, whether they be normal or abnormal, can be recorded on films, giving to these real diagnostic significance. If this statement is accepted, it follows that the primary purpose of fluoroscopy is to control the exposure of the roentgenograms.

If films are to play more important roles than they now do in most gastro-intestinal roentgen examinations, the diagnostic criteria must be based almost entirely on anatomic-pathologic changes. Anatomic-physiologic changes, such as those produced by peristalsis, tonus, and local contractions, while extremely helpful in some instances, can be recorded only by taking a series of several films with the patient's position unchanged or by observing the changing image under the fluoroscope. As helpful as peristalsis and tonus are in determining stiffening or pliability of the walls, certain limitations exist. Peristaltic waves either fail to appear when desired, are too shallow to be of much aid, or do not affect the zones of interest. The cardiac end of the stomach is an example of the latter.

With few exceptions, lesions which interfere with peristalsis produce anatomic abnormalities that can be detected by adequate technic. Some lesions, such as carcinoma, which are thought to produce their earliest signs by peristaltic paralysis, do not always do so. The abnormal variations in contours of the lumen or mucosal pattern produced by most ulcers must be demonstrated if one is to arrive at an unqualified diagnosis of ulcerous disease, even though peristaltic activity is altered. Proof that certain changes in physiology, such as "hyperperistalsis," "irritability," "delayed emptying," and "retention," are

sufficient signs on which to base a diagnosis of ulcer is lacking. These signs are significant only if they are accompanied by demonstrable pathologic-anatomic changes. It is feasible and time-saving to locate lesions by observing the changes these abnormalities produce on the walls, seen in profile, and in the mucosal pattern. The identifying criteria for ulcers and their differentiation from spurious patterns have been described (1-4). There are, of course, findings of which one cannot be certain. Such situations are true of any diagnostic procedure, no matter how great the accuracy claimed for it. Supplementary examinations are essential for further evaluation. A detailed study of the physiologic variations often proves most helpful in these instances.

Representative films of various sections of the gastro-intestinal tract can be obtained with the filming-fluoroscope or "spot" machine. Best results are obtained by skilled operators who take routine exposures of various sections of the stomach and bulb during the course of the examination. By this method, lesions not seen at the fluoroscopic examination are detected. Those who record only abnormal shadows seen at fluoroscopy cannot realize the number of lesions overlooked, since the indications for surgical procedure, and even gastroscopic examination, are often dependent upon the results of a roentgen study.

Films, particularly spot films, are a most reliable medium for judging the quality of a fluoroscopic examination. Those who become expert in recording the significant images on spot films also perform creditable fluoroscopic examinations. Those who experience trouble in mastering the technic of using the filming-fluoroscope sometimes criticize the machine rather than themselves. This is a common human tendency. There is, I am sure, a direct relationship between the quality of the fluoroscopic examination and the quality of the films recorded.

The value of films in diagnosis and research cannot be overestimated. By re-

ording images in their nearly true form, by studying these permanent records at leisure, and by comparing the results with pathologic specimens, one becomes more and more proficient, not only in interpreting the films but also in observing significant changes at fluoroscopy. Permanent records are valuable to compare pathologic data and in following peptic ulcers during treatment, where one wishes to estimate the efficiency of medical management. Estimates as to the size of a crater from the fluoroscopic image do not always agree with the measurements on the films. Furthermore, the crater as it becomes smaller and smaller is lost at fluoroscopy before it is lost on the roentgenogram.

In closing, the following points are emphasized. Both fluoroscopy and films are essential parts of a good gastro-intestinal examination. Films properly made reveal enough data to allow a diagnosis in most instances, but such films cannot be obtained without fluoroscopic control. Significant images overlooked at fluoroscopic examination can be recorded on films, therefore routine films should be made of the various sections of the tract during the examination. It is obvious that objective evidence of a lesion is much more reassuring than subjective, not only to the radiologist but also the clinician who refers the patient. If the radiologist depends entirely or almost entirely upon fluoroscopy, the clinician is forced to view his patient through the eyes of the fluoroscopist and is denied the privilege of having objective data from which he can draw his own conclusions.

The confidence the clinician has in his radiologist is undermined by each lesion the latter fails to find. By reviewing the films which record the progress of the examination, both clinician and radiologist may find that the lesion occurred in a manner not possible to demonstrate with the technics in vogue. The clinician thus becomes more understanding of radiologic problems. Unfortunately, most errors can be traced to a break in routine, a fault which is much more evident from a review of films than of fluoroscopic notes.

To obtain representative films requires considerable skill and experience on the part of the radiologist, and deficiencies in technic are more obvious in one who uses the spot machine than in one whose sole reliance is on the fluoroscope. To keep up with expanding health programs, more thought will have to be given to the technic of examining the gastro-intestinal tract than it has received in the past, from the standpoint of increased accuracy and decreased radiation hazards to both the patient and the examiner.

414 Cobb Bldg
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SUMARIO

Úlcera Péptica Importancia de las Radiografías en el Diagnóstico

Para un buen examen gastrointestinal, resultan indispensables tanto la roentgenoscopia como las radiografías, y en particular las radiografías tomadas en el transcurso de la roentgenoscopia. Sin embargo, hay que hacer mayor hincapié en el papel desempeñado por las últimas, sobre todo en el

diagnóstico de la úlcera gástrica y duodenal. Las radiografías debidamente obtenidas revelan suficientes datos para permitir el diagnóstico en la mayor parte de los casos, pero no pueden obtenerse sin comprobación roentgenoscópica. Una alteración importante que se pasa por alto en

la roentgenoscopia puede ser registrada en la radiografía por cuya razón deben tomarse durante el examen radiografías corrientes de varios sectores del aparato gastrointestinal. Esos registros permanentes permiten estudio más detenido, comparación con los hallazgos patológicos y mejor apreciación de los efectos del tratamiento, facilitando además datos objetivos para el clínico que, de otro modo, sólo podría contemplar a su enfermo por los ojos del roentgenoscopista.

La obtención de radiografías adecuadas exige destreza y experiencia de parte del radiólogo, pues las deficiencias técnicas resaltan más en ellas que en el examen roentgenoscópico solo. A fin de mantenerse en ritmo con la expansión de las obras sanitarias, hay que prestar mayor consideración a la técnica del examen radiológico del aparato digestivo, desde el punto de vista tanto del aumento de la exactitud como de la disminución de los riesgos de la irradiación.



Place of Fluoroscopy in the Diagnosis of Peptic Ulcer¹

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RUSSELL D. CARMAN, who, if not the father of roentgenoscopy in this country, is certainly the first active protagonist (Brown), stated in 1920, and iterated in the earlier edition of his book and papers "I believe that the advantages of the screen in examination of the digestive tract can hardly be too strongly emphasized. Only by its use can exact information be obtained as to mobility and flexibility, the phenomena of peristalsis and antiperistalsis, the nature and permanence of irregularities of contour and effects of palpation, respiratory movement and varying positions. All changes can be seen at every instant, in the order of their succession, at any desired angle, and in these respects a few minutes of screening is equivalent to hundreds of plates." Plates were used mainly to record findings and only secondarily to check them. This tradition has been carried on and amplified, and the technic has been improved, by Carman's associates and successors, Drs. A. B. Moore, B. R. Kirklin, John D. Camp, and H. M. Weber.

It is comparatively recently that filming fluoroscopes or fluoroscopes with spot-film devices have been made available by the manufacturers of x-ray apparatus in this country (Templeton). Along with their availability, there has developed an intimation of controversy in x-ray diagnostic circles relative to the evaluation of the different methods of examination of the gastro-intestinal tract. Those who use the films taken during fluoroscopy as the main factor in diagnosis belittle those who depend primarily on the fluoroscopic observations and on films secondarily, and claim that the former method results in better detail and more accurate diagnosis.

It is my thesis that fluoroscopy and the

few films necessary to record the findings are capable of extremely accurate and confirmable results when used by certain radiologists, *i.e.*, those trained by long experience and capable of substituting for the sharply focused macular vision used with intense light, the low intensity (retinal) rod vision necessary for viewing the screen image. This facility is an art requiring sharp visual acuity, mental alertness, and co-ordination far beyond that needed for mere observation of the varying densities of a photographic emulsion. It is not for those incapable of seeing the wealth of detail that can be revealed by the fluoroscopic screen and the proper manipulation of the patient and the shutters.

The fluoroscope itself should be as an old friend—well known, with few eccentricities. The manipulation should be an unconscious co-ordination of eyes, hands, and controls, such as only the familiarity of constant use can confer. The screen and tube carriage should float, move with little effort, and stay put when stationary. The shutter controls should obey the slightest motion of the hand—something lacking in the Belden cable control used in most of the present left-handed tilting fluoroscopes. Certainly, many of the European and late model American filming fluoroscopes, with their clumsy, cumbersome screen carriages, littered with levers, cassette holders, shifters, buttons, and now a photocell, with a tiny screen, are not conducive to relaxed subconscious manipulation. With all the mental and physical effort necessary in the manipulation of such apparatus, fluoroscopy becomes very casual, as the fluoroscopist must be busy taking films.

There is no question but that films

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should be taken of the organs under examination. There is also no question but that the filming fluoroscope is capable of taking these at the time of seeing the parts on the screen much more readily than taking them in a routine position. The question of dependence on the films thus made as a method of recording the fluoroscopic findings or as a major method of diagnosis is one for the individual examiner. Certainly there are radiologists who, because of an inherent inability to see well in the dark, should not depend on the fluoroscope in diagnosis, but should use it more or less for positioning, depending on the films produced for the final conclusion. All roentgenologists should test their visual acuity by methods advocated by Chamberlain and others.

It might be well to mention mechanical, psychological, and other factors which should be considered in making an adequate fluoroscopic examination. These are, in brief outline, the teachings of my preceptor, Dr B. R. Kirklin, as I remember and apply them. In his paper before the Radiological Society of North America (1935), the technic of the examination is outlined in his lucid and striking manner.

In addition to the gross mechanical attributes of a "good" fluoroscope mentioned above, the type of tube and screen must be considered. A fine focal spot is essential. In spite of some who say otherwise, one can tell the difference in screen detail between a 1.5 mm. focal spot and a 3.0 mm. spot, this at the usual 12 to 14 inch distance of the tube from the table. At a distance of 20 inches or more, as advocated by Chamberlain, this difference would not be so evident. The screen should be as fast as possible without obvious graininess, producing good illumination, but with good contrast characteristics. Such a screen is the new Patterson type B-2.

The contrast medium to be used is important only in that it should be fluid enough to flow easily, and at the same time be sufficiently dense to obscure *on the screen* all bone and soft tissue detail, even

in fairly thin layers. Flavored suspending agents usually produce too thick a mixture, and are still ineffective in disguising the taste of the barium sulfate. A drop of peppermint oil to a glass results in fewer objections to the mixture (Garland).

An important factor in fluoroscopy is the attitude of the patient under examination. For practically all, it is a new experience and nearly all are apprehensive, to say the least. Here the attitude of the personnel in the department is important. They should be cheerful, handle the patient as little as possible, and work toward putting him at ease. Most of the patients do not know how to relax, and must be told (Carman) to bend the head forward, allow the shoulders to relax, with the arms at the sides, and to let the abdomen sag. This procedure allows the stomach in all but those of the most hypersthenic habitus to come down below the costal margin, where all of it, except the fundus, can be palpated.

The question of dark adaptation before fluoroscopic examinations cannot be too greatly stressed. Chamberlain in his classic review of fluoroscopes and fluoroscopy in the Carman Lecture of 1941 has compiled data of great value. He outlines the scientific basis for prolonged dark adaptation before attempting fluoroscopy. Certainly, no one expecting to do adequate work will take less than thirty minutes to adapt his eyes, if he has been in bright sunlight, allowing for proportionally shorter times when adapting from a room with artificial illumination. The use of red goggles permits one to undertake such other duties as dictating letters, etc., even to driving a car. It must be understood that they do not shorten the time of dark adaptation. Actually they should be supplemented by three to five minutes in a dark room to adapt the retinal cones to dim illumination.

After observation of the screen image, palpation is the next most important part of the examination. The co-ordination of the eye and the hand is most essential.

and comes only with training and experience. It is quite obvious that only gross abnormalities are to be felt with the hand encased in a heavy lead glove. I do not hesitate to recommend the removal of that glove for direct palpation under fluoroscopic vision, provided the screen opening is kept small, the hand kept behind the barium shadow, and above all not placed in the direct beam. This advice is good, also, for those who depend on gloves for protection of the hand, for the 0.5 mm lead equivalent in lead rubber does not give adequate protection in the direct beam of 80 to 90 kv x-rays. One must remember that the black image of the glove seen on the screen is produced by two layers of the material, while the fingers are protected by only one.

The third most important factor in fluoroscopy is the proper use of the shutters. The screen opening should be as small as will give the maximum contrast between the barium-filled organ and the surrounding tissues. A set aperture cannot be used, for the illuminated portions of the screen should not exceed the shadow of the organ more than a centimeter or two. This requires constant adjustment of the shutters. A small shutter opening also affords considerable protection to the patient and to the examiner.

During the examination of the stomach, the first step should be the ingestion of a small amount of barium sulfate suspension, which should be manipulated to delineate the rugal folds of the entire stomach. Attention should be given to even slight variation from the normal configuration and it should be evaluated. The direct visualization of an ulcer crater is usually possible, if one is present. However, if there is a spastic incisura, shortening of the lesser curvature, or spasm of the gastric antrum without visualization of a crater, its presence should still be suspected and a re-examination should be made after administration of antispasmodics, if necessary, to confirm or rule it out (Carman). Sharply localized tenderness is also a suspicious finding.

After a thorough survey of the mucosal folds, the stomach should be distended with the barium sulfate suspension. The patient should then be turned in different positions for visualization of the walls of the stomach, especially the posterior wall along the length of the lesser curvature, as the examiner watches for the niche of a penetrating ulcer. The fundus can then be further examined by pressing the mixture upwards. (Supine and prone views of the fundus are also important.)

By the time this has been done, the pylorus has probably relaxed. It is at this point that proper relaxation of the patient is most important. All the manipulation possible will not force barium through the pylorus of a stomach with an atonic antrum. Reassurance of the patient, the mentioning of food, and gentle stroking of the antrum will increase its tone and further relax the pylorus. Peristalsis, helped by the manipulation, will then fill the cap. The type of manipulation is important. Pressing on the antrum, in an attempt to push the barium through the pylorus, results in compressing the cap against the liver and prevents the cap from filling. The proper procedure is to allow the antrum to fill by peristalsis, then, with just enough pressure to approximate the walls of the stomach, the cupped right hand is placed over the body of the stomach, at or just above the angle, and gentle downward pressure is produced in order to increase the intragastric pressure in the antrum. The cap then fills readily after one or two trials. Further increase of the pressure in the antrum may be obtained by pressure over it with the left thumb, which is then in position to obstruct the third portion of the duodenum, if necessary, to keep the cap filled. After the cap is filled, it is palpated and manipulated to disclose the folds of the mucosa. The variations of normal here are greater than those in the stomach, but departures from normal are equally important.

The importance of completely distending the cap cannot be stressed too much. In the absence of a previous surgical pro-

cedure in the region (especially involving the gallbladder), any persistent deformity of the cap represents a scar of a duodenal ulcer (Cole) and one in which active disease may be present. If the cap is not completely distended, apparent but not real deformity may be present and be quite persistent. The presence of a persistent fleck of barium surrounded by an areola of edematous tissue represents a penetrating ulcer crater on the anterior or posterior wall of the duodenum. A niche at the edge of the cap shadow, if it can be differentiated from a scar deformity or a pseudo-diverticulum, also represents an active crater. These changes do not require films for their differentiation, but can be easily outlined on the screen. There is no question in my mind that they represent active disease—disease that can be confirmed by the surgeon or pathologist and fit the clinical picture of an active ulcer. However, active ulceration in the duodenum is not necessarily a process of ulcerous penetration. It can be an inflammatory infiltration of the duodenal wall without superficial ulcer or ulcers in the overlying mucosa. The only finding, either fluoroscopically or on film examination, is the persistent deformity. The determination of the activity of the process then depends on the clinical findings. One should remember that the clinician can help in differentiation and that the roentgenologist does not have to take the whole load on his shoulders, even if at times he is expected to do so.

The question of disappearance of the crater of a penetrating ulcer in the stomach as an indication of healing is an important one. Certainly ulcers under 10 mm in diameter, located near or on the lesser curvature, can be considered to be healed when they disappear. Elsewhere in the stomach disappearance of an ulcer should be checked, not once, but several times before presuming that it is healed. Ulcers of any size on the greater curvature are so nearly always malignant that they should be treated as such after the initial diagnosis. The disappearance of an ulcer

crater in the duodenum is presumptive evidence of healing, for the time being. It may, and probably will, recur after an interval, on the assumption of "once a duodenal ulcer, always a duodenal ulcer."

All these findings, seen so well under the fluoroscope and so easily recorded on films, are confirmable anatomically by the surgeon or pathologist. One questions the thesis of those whose main dependence is on films made during the screening of the patient, that the finer detail (especially the mucosa) produced on the films is of any particular significance. One might argue also that this method results in earlier diagnosis. However, in our office we have records, going back over many years, of patients with gastro-intestinal symptoms who persistently have shown no evidence of active disease. As a matter of fact, I remember only one patient who, examined at intervals over a period of about twenty years, finally was shown to have a duodenal ulcer at the age of sixty, and this after a period of about two years of symptoms considerably different from the previous ones.

Only very rarely does one find it necessary to re-examine the patient because of some suspicious findings on the films taken subsequent to the screen examination. One soon learns to anticipate possible film findings and thus check them beforehand.

In conclusion, the fluoroscope is the prime instrument in the x-ray diagnosis of diseases of the stomach and duodenum in the hands of roentgenologists capable of making full use of its facilities. Films for recording and checking the findings are necessary, but are of secondary importance. The demonstration of a penetrating ulcer in the stomach or duodenum indicates an active ulcer, disappearance of the crater is indicative of healing in duodenal ulcer, and probable healing of small ulcers on or near the lesser curvature of the stomach. Findings thus seen fluoroscopically and recorded on films can be confirmed anatomically, and it is not necessary to produce, by special proce-

dures during the examination, films on which prime dependence for the diagnosis is placed

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SUMARIO

Puesto de la Roentgenoscopia en el Diagnóstico de la Úlcera Péptica

El roentgenoscopio es el instrumento primordial para el diagnóstico roentgenológico de las enfermedades del estómago y el duodeno en manos del radiólogo capaz de usar plenamente sus recursos. Exige, sin embargo, pronunciada agudeza visual, viveza mental, y coordinación muy superior a la necesaria para la mera observación de los distintos espesores en la película roentgenológica. Las radiografías dedicadas a registrar y comprobar los hallazgos son necesarias, pero revisten importancia secundaria.

La observación de una úlcera penetrante en el estómago o duodeno indica úlcera activa, la desaparición del cráter denota cicatrización en la úlcera duodenal y probable cicatrización en las ulcerillas de, o cerca de, la curvatura menor del estómago. Los signos así observados roentgenoscópicamente y registrados en las radiografías pueden ser confirmados anatómicamente, sin que sea necesario producir, por medio de procedimientos especiales durante el examen, radiografías en las que se base principalmente el diagnóstico.



Physical Problems of Fluoroscopy and Spot-Film Radiography¹

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THE PHYSICAL problems of fluoroscopy and spot-film radiography may be divided into two principal categories (a) those concerned with the radiation hazards to which the patient and radiologist are exposed during the performance of the procedures and (b) those concerned with the poor visibility which prevails during any fluoroscopic examination and especially during the fluoroscopic study of such heavy structures as the abdomen

RADIATION HAZARDS

The effects of x-radiation on biological tissues are generally deleterious, and it is therefore important that the radiation to which the patient is exposed during gastro-intestinal study be maintained at a low value. This requires that the study be carried out under conditions in which the field of vision is restricted by the fluoroscopic shutters to the smallest possible size consistent with an adequate appreciation of the anatomical relationships under study and in which the time of exposure is reduced to the shortest possible interval consistent with a complete examination. Although the biophysicists who recently have expressed so much concern over the delivery of even minute quantities of x-radiation to the body are possibly unnecessarily apprehensive, there can be little doubt that fluoroscopic examinations in which the shutters are opened to give an aperture of the order of 200 square inches for periods of ten and fifteen minutes should be condemned. Unfortunately there are a few radiologists, and many more internists whose offices are equipped with fluoroscopic apparatus, who regularly persist in conducting their fluoroscopic procedures in just such a manner. It is

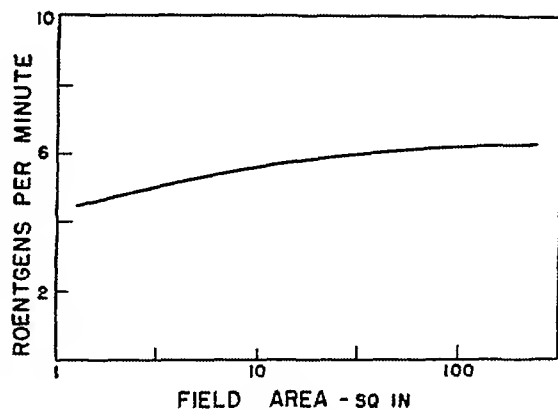


Fig 1 Effect of field size on the roentgen dosage received by the incident skin surface of a patient during fluoroscopy. Conditions of exposure: tube potential, 85 kv p, tube current, 4 ma, filter, 3 mm Al, target-table top distance, 18 inches, phantom, 20 cm of masonite tempered presdwood, field size measured at fluoroscopic screen, roentgen measurements include back scatter.

therefore hoped that before long the screens with which conventional fluoroscopes are equipped will be reduced in size, either by convention or by regulation, to dimensions considerably smaller than the 12 X 16 inches now provided.

Experience gained at the University of Chicago Clinics and the Johns Hopkins Hospital, where fluoroscopic screens of the order of 30 to 50 square inches have been in regular service for periods of several years, indicates that such small screens constitute no clinical problem in the examination of any anatomical structure. The small field sizes imposed by these screens have done much to reduce the radiation exposure of the patients who have been examined. This is well shown in Figure 1, where the dosage in roentgens, including back-scatter, received at the incident surface of a phantom of tempered masonite presdwood, 20 cm in thickness, is plotted as a function of the field of observation on

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the fluoroscopic screen. The measurements were made with a fluoroscope operating at 85 kv p and 4 ma, with a filter of 3 mm of aluminum and with a target-table top distance of 18 inches. It will be observed that the dosage becomes greater as the field size increases. This rise in dosage, however, does not indicate the entire radiation hazard. When the field of observation is small, the total length of time during which a *particular* area is exposed during an examination is likely to be considerably shorter than when the field is large, since in the latter case there will be considerable overlapping of the fields of observation from one moment to the next.

The long periods of fluoroscopy which some physicians require for examination of the alimentary tract can also constitute a serious radiation problem. It may be argued by some that prolonged fluoroscopy is frequently necessary to perform a *complete* examination. This stand, however, does not seem to be justified either by practical or experimental observations. Although there have been no serious studies on the psychological aspects of fluoroscopic vision, preliminary investigations which we have undertaken in this field indicate that almost all of the intelligence recorded on a fluoroscopic screen is appreciated by the observer within a few seconds after the image has appeared on the screen. Long periods of further scrutiny are usually of little value in determining additional diagnostic information. While the speed of intelligence-appreciation by an observer depends to a great extent on his experience, there seems to be little reason why the great majority of gastro-intestinal examinations need be prolonged beyond a period of five minutes of actual fluoroscopy for the average radiologist.

Such a period of fluoroscopy, when performed by a fluoroscope operating at 85 kv p and 4 ma, with a target-table top distance of 18 inches and a filter of 3 mm of aluminum, with a field size sufficient to produce a screen image 40 square inches in area, will result in the delivery

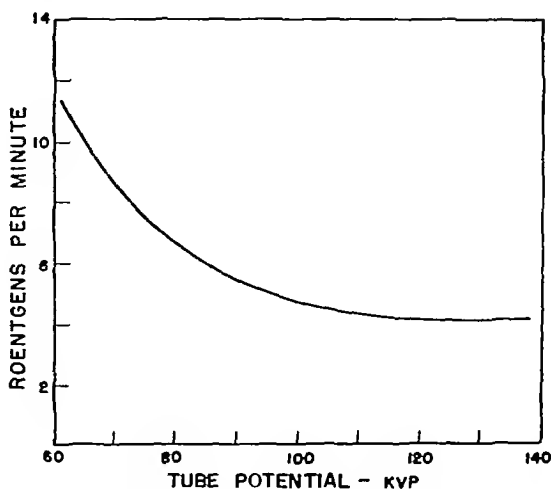


Fig 2 Effect of x ray tube potential on the roentgen dosage received by the incident skin surface of a patient during fluoroscopy. Conditions of exposure: tube current varied to maintain screen brightness constant at various tube potentials, field size 40 square inches, other conditions as given for Figure 1.

of a total of 30 r, including back-scatter, to the skin of a patient 20 cm in thickness. The exposure to which any particular area of the skin is subjected will, of course, be smaller than this total value. The exposure does not seem excessive.

The size of the field of observation and the time taken for the performance of an examination do not constitute the only factors which control the radiation dosage during fluoroscopy. The kilovoltage applied to the roentgen tube, the target-table top distance, and the filtration in the roentgen beam also influence the quantity of radiation to which a patient is subjected. In Figure 2 is shown the dosage, including back-scatter, delivered to a tempered masonite phantom, 20 cm in thickness, during fluoroscopy with a roentgen generator operating at various tube potentials. The data were obtained under conditions in which the tube current was varied so as to yield a screen brightness that remained constant throughout the range of kilovoltage studied (at 85 kv p the tube current was 40 ma). The roentgen beam was filtered with 3 mm of aluminum, the target-table top distance was 18 inches, and the field of observation was 40 square inches on the screen. It will be observed that for a given screen brightness, the ex-

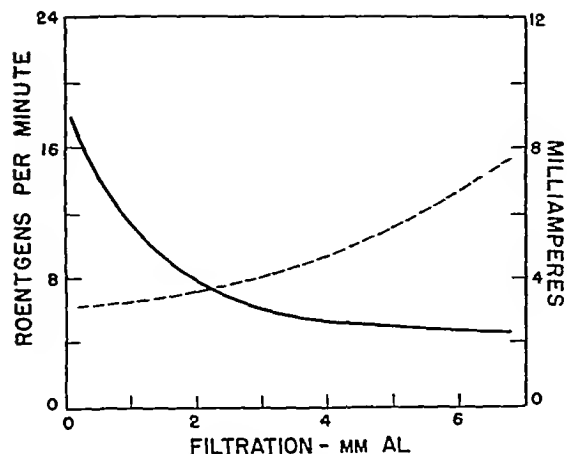


Fig 3 Effect of aluminum filtration on the roentgen dosage received by the incident skin surface of a patient during fluoroscopy. Conditions of exposure: tube current varied to maintain screen brightness constant at various filter thicknesses, field size, 40 square inches, other conditions as given for Figure 1.

posure received by a patient diminishes as the tube potential is raised until a voltage of about 130 kVp is reached. Thereafter, there is a slight rise in the dosage value. From this, it would appear that fluoroscopy should be performed at tube potentials higher than those now used. However, it will be noted that the dosage conditions at 85 to 100 kVp are little less satisfactory than at 130 kVp, and there seems to be no great need, therefore, for higher kilovoltages than those now generally employed from the standpoint of the radiation hazard involved.

The diminished dosage that occurs when the tube potential is increased is caused by changes in the spectral distribution of the radiation projected through the patient. When the potential rises, the fraction of the radiation which is composed of easily absorbed long-wave-length components diminishes and accordingly the dosage rate decreases. One should therefore expect that filtration in the roentgen beam might also affect the amount of radiation delivered to a patient during fluoroscopy. The magnitude of this effect is shown graphically in Figure 3, where the roentgen dosage, including back-scatter, delivered to a tempered masonite phantom, 20 cm in thickness, when fluoroscoped by a roentgen generator operating at 85 kVp, is

plotted against thickness of aluminum filtration placed in the beam. These measurements were made with a roentgen tube having an inherent filtration of 0.7 mm of aluminum, and operating at tube currents which yielded a screen brightness that remained constant through the range of filter thickness studied (at 3 mm of aluminum the tube current was 40 ma). The target-table top distance was 18 inches and the field of observation was 40 square inches at the screen.

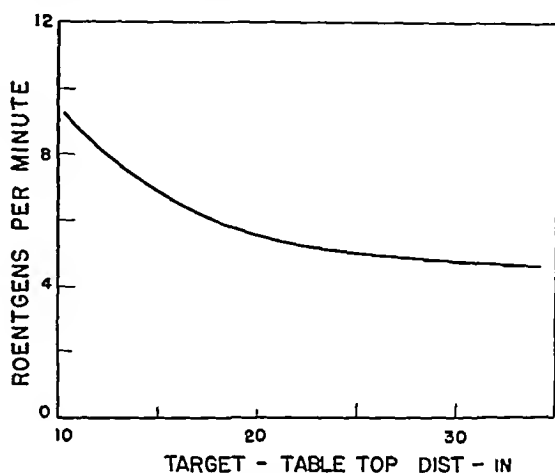


Fig 4 Effect of target-table top distance on the roentgen exposure delivered to the incident skin surface of a patient during fluoroscopy. Conditions of exposure: tube current varied to maintain screen brightness constant at various target-table top distances, field size, 40 square inches, other conditions as given for Figure 1.

It will be observed that increases in filter thickness markedly decrease the incident radiation dosage received by the patient. Furthermore, this effect is obtained at very little cost in extra milliamperage needed to maintain the screen at its original brightness (see dotted curve in Fig 3). It therefore appears that more filtration than that customarily used in the roentgen beam during fluoroscopy is desirable, indeed, filters of 2 to 4 mm in thickness should provide very real reductions in the quantity of radiation to which patients are subjected during fluoroscopy.

In recent years, considerable attention has been given to the effect of increased target-table top distances in decreasing the radiation exposure of a patient (1)

This effect, however, is not as great as might be anticipated. In Figure 4, the roentgen dosage, including back-scatter, delivered to a tempered masonite phantom, 20 cm in thickness, when fluoroscoped with a roentgen generator operating at 85 kv p, and filtered with 3 mm of aluminum, is plotted as a function of the target-table top distance. These data were obtained with the roentgen tube operating at currents such that the brightness of the fluoroscopic screen remained constant throughout the ranges of target-table top distances studied. It will be observed that, although the roentgen dosage rate diminishes as the target-table top distance increases, the change is not great for values over 15 inches, for example, the dosage rate is only down 16 per cent when the distance is increased from 15 to 20 inches.

The effect of spot-film radiography on the quantity of radiation delivered to a patient during fluoroscopy has been of considerable concern to many radiologists in recent years. There seems, however, to be little basis for this apprehension. The quantity of radiation delivered at each spot-film exposure will, of course, depend on the equipment on which the films are made, but with conventional equipment the exposures may be expected to be of the order of 20 to 50 ma-seconds. If a series of six films is made (possibly the number needed for the complete study of an average individual), 120 to 300 ma-seconds will constitute the necessary exposure for the entire set of films. However, if the patient is fluoroscoped for a period of five minutes at a tube current of let us say 40 ma, the total fluoroscopic exposure will approach 1,200 ma-seconds. Thus, the set of spot-films will constitute a roentgen exposure of only 10 to 25 per cent of that received during fluoroscopy. Such an extra exposure can hardly be thought deleterious in view of our knowledge of the relatively large percentage changes in radiation exposure needed to produce a change in biological reaction.

Although spot-film radiography in general appears to be a safe procedure from the

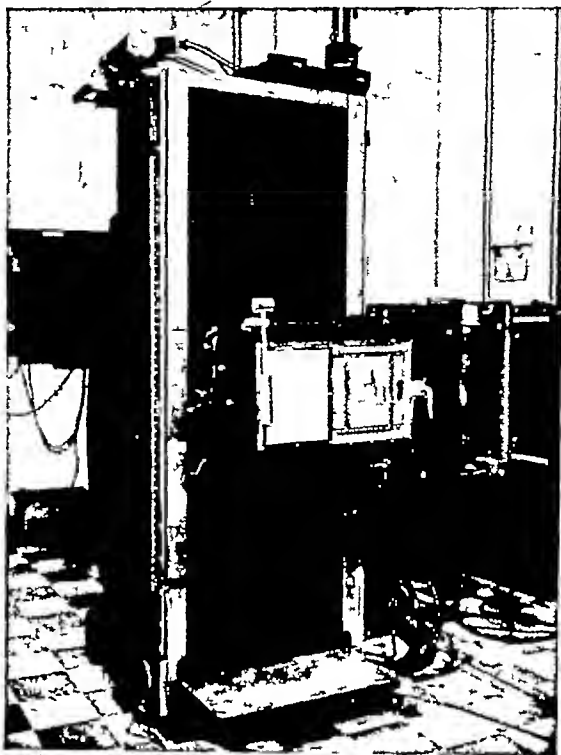


Fig 5 Spot-film fluoroscope constructed in the radiology model shop of the Johns Hopkins Hospital Unit includes fine focus rotating anode tube, moving grid automatic photoelectric timer and compression apparatus independent of field-limiting devices. Table-tilting mechanism is electrically activated by a switch on the front of the screen to facilitate operation of the table with sick patients. A low-intensity pilot light at the top of the screen has been added to throw light on barium glasses when they are handed to patients. Light comes on when red light of room is lighted.

standpoint of radiation hazard, there is one practice that is commonly employed in the method that has considerable potential danger, that is the practice of using field-limiting compression devices when one is seeking mucosal relief views of the stomach or duodenum. These devices are normally located between the patient and screen and, when in place, permit the fluoroscopist to examine the patient with good visibility even though the shutters of the fluoroscope may be wide open. Indeed, unless great care is exercised by the radiologist, films will be made under this undesirable condition more often than not. If adequate protection is to be maintained, the devices that are used for compression should not be devices that also limit the field of fluoroscopic vision. Furthermore,

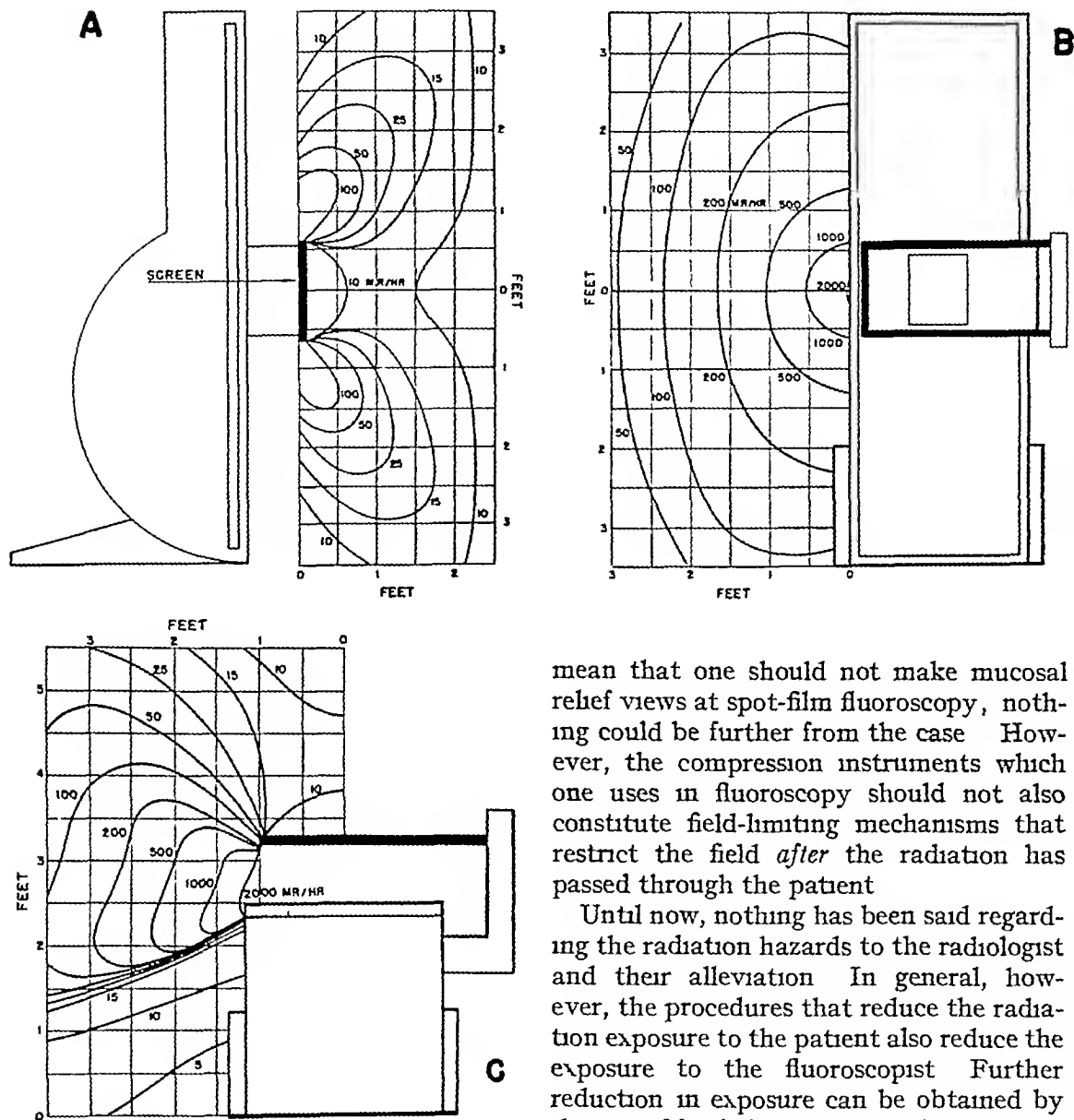


Fig 6 Isodose curves showing exposure in milliroentgens per hour about fluoroscope shown in Figure 5 during fluoroscopy A Sagittal plane in front of fluoroscope B Coronal plane laterally from fluoroscopic screen C Transverse plane through the table Exposure conditions tube potential 85 kv p, tube current, 4 ma, filter 3 mm Al, target-table top distance, 18 inches field size, 80 square inches at screen phantom masonite tempered preswood 20 cm thick 30 cm wide, and 60 cm long

field-limiting devices should never be placed between the patient and screen but always between the roentgen tube and the patient unless some automatic mechanism is provided to limit the shutter opening when the device is in place This does not

mean that one should not make mucosal relief views at spot-film fluoroscopy, nothing could be further from the case However, the compression instruments which one uses in fluoroscopy should not also constitute field-limiting mechanisms that restrict the field *after* the radiation has passed through the patient

Until now, nothing has been said regarding the radiation hazards to the radiologist and their alleviation In general, however, the procedures that reduce the radiation exposure to the patient also reduce the exposure to the fluoroscopist Further reduction in exposure can be obtained by the use of leaded aprons and gloves The most effective use of these materials by a given fluoroscopist can be determined, however, only with a knowledge of the radiation exposure conditions about his fluoroscope It is unfortunate—and a disappointing commentary on the roentgen industry—that no manufacturer of fluoroscopic equipment publishes such data at the present time

The radiation exposure conditions about one of the fluoroscopes (Fig 5) which we have recently placed in operation are illustrated in Figure 6A-C This fluoroscope is basically a Westinghouse Duoflex model

that has been altered in our laboratory shops to permit the same flexibility in spot-film radiography as is provided by the fluoroscope designed by Hodges and described by Templeton (2). The maximum field of vision at the screen is 80 square inches. All of the data presented in Figure 6 were obtained with a tempered masonite presdwood phantom 20 cm in thickness, 30 cm wide, and 60 cm long. The fluoroscopic beam was provided by a generator operating at 85 kv p and 40 ma. The beam had a filter of 3 mm of aluminum, the target-table top distance was 18 inches, and the observational field at the screen was 80 square inches. Figure 6A shows the exposure conditions in a sagittal plane in front of the fluoroscopic screen, the data in Figure 6B indicate the exposure conditions in a coronal plane laterally from the fluoroscopic screen, while those in Figure 6C are in a transverse plane through the table. It will be observed that the danger areas extend (a) laterally on either side of the fluoroscopic screen in a direction where the radiologist stands while examining the patient in the recumbent position and (b) anteriorly above and below the fluoroscopic screen where the radiologist sits when examining the patient in the vertical position. Almost all of the radiation exposure occurring in these two locations is composed of scattered radiation arising in the patient. The lead glass covering the fluoroscopic screen appears to prevent effectively the transmission of significant quantities of direct radiation.

Leaded aprons are fairly efficient in absorbing the scattered radiation to which the radiologist is exposed. One commercial apron having a lead equivalence of 0.5 mm transmitted only 1 per cent of the scattered radiation incident upon it under the conditions which were employed for the collection of the data illustrated in Figure 6. It appears, therefore, that such an apron will provide sufficient protection to enable the radiologist to conduct fluoroscopic examinations for considerable periods each day without exceeding an exposure of 0.1 r at any location about the

fluoroscope. However, it must be pointed out that present-day aprons do not always cover the body in the regions where maximum exposure is encountered. For example, in Figure 6A, it will be seen that the area of greatest danger occurs immediately below the fluoroscopic screen, where the shoulders and neck of the fluoroscopist, unprotected by conventional aprons, are located. It therefore seems desirable that additional protective measures, such as leaded rubber curtains, be placed about the bottom of the fluoroscopic screen to insure the absorption of the high-intensity radiation which exists at this location.

Before leaving the problems of radiation protection in fluoroscopy, it may be well to say a word or two regarding the hazards of placing the hand in the so-called direct roentgen beam between the patient and the fluoroscopic screen. Measurements of the radiation exposure existing within a 2-ply Liberty Dressing Company glove when placed in the center of the irradiated field in front of a 20-cm presdwood phantom with the fluoroscope operating at 85 kv p and 40 ma, with 3 mm of aluminum filtration, and with an 18-inch target-table top distance, indicate that 0.05 r per hour may be expected at this location. It therefore appears that the hand of the operator, when protected by such a glove, may be placed in the direct beam for short periods. In this connection, it is regrettable that present-day gloves do not cover more of the forearm. It is apparent from Figure 6A that, when the protected hand is placed in the direct roentgen beam, the unprotected forearm is exposed to undesirably high radiation intensities scattered outside the direct beam.

FLUOROSCOPIC VISIBILITY

The poor visibility which prevails during fluoroscopy is well known. Its cause is not to be found in any deficiencies of the fluoroscopic screen or even within the human visual mechanism, but instead in the relatively large statistical fluctuations which exist from moment to moment in the intensity of the fluoroscopic beam.

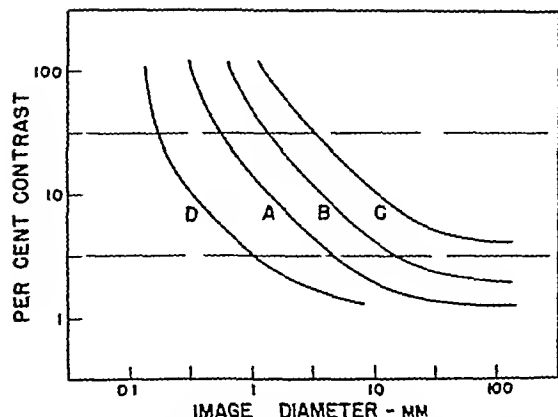


Fig 7 Visual performance curves in which per cent threshold contrast is plotted as a function of minimum perceptible image diameter during fluoroscopy. A 10-cm presdwood phantom B 20-cm presdwood phantom C 30-cm presdwood phantom Exposure conditions tube potential, 85 kv p, tube current 4 ma, filter, 3 mm Al target-table top distance, 18 inches screen Patterson B-2 field size 80 square inches Curve D indicates visual performance during radiography with Patterson par speed screens and Eastman blue brand film

These fluctuations could be reduced and visibility improved by increasing the beam intensity several hundred times. However, such a solution to the problem is obviously impractical. Another solution is the development of an electronic screen intensifier by which the brightness of the fluoroscopic screen could be increased and the fluctuations in the screen's light output reduced to at least some extent (3). Although such screen intensifiers are now in the experimental stage, practical devices will probably not be available for a few years, and it appears that for some time to come poor fluoroscopic visibility will continue to be the rule.

Fluoroscopic visibility is a function of the sizes of the images under observation and of the contrast they exhibit with their surrounding fields. This is well shown in Figure 7, where the smallest image size which may be perceived at fluoroscopy is plotted as a function of image contrast for conditions where the roentgen generator is operating at 85 kv p and 40 ma, with a 3-mm aluminum filter, an 18-inch target-table top distance, and with a Patterson type B-2 screen. Curves A, B, and C represent conditions respectively when

the structure under observation is equivalent to 10, 20, and 30 cm of masonite presdwood in thickness. Images of sizes and contrasts that fall above and to the right of each curve are readily seen, those that fall below and to the left of each curve are invisible. The range of contrast between the dotted lines is the range normally encountered in fluoroscopic practice.

The threshold visibility data for radiography are depicted in curve D of Figure 7. It will be noted that visual performance at radiography is markedly better than that at fluoroscopy. For example, an image of 30 per cent contrast must be fifteen times larger to be seen at abdominal fluoroscopy (equal to 20 cm of presdwood) than at radiography.

In the absence of screen intensification systems, radiologists long ago began using spot-film radiography for better visualization of the gastro-intestinal tract. Although spot-film technics have been widely used, it is rather surprising that they have not received an overwhelmingly enthusiastic reception in view of the data illustrated in Figure 7. One reason for this may be the radiation hazard that is involved. However, as we have pointed out above, the procedure involves no serious radiation hazard. The major reason why spot-film technics are not universally used is probably the poor quality of the films that may be obtained with conventional fluoroscopic equipment at the present time. The performance of almost all of these devices falls far short of curve D in Figure 7. This is due, first, to the large focal spot sizes that are often used for spot-film radiography and which produce blurring of the images, second, to the difficulty of frequent and correct adjustment of the exposure factors of the x-ray machine as the examination proceeds so that properly exposed films will be consistently produced. By and large, gastro-intestinal spot-films are usually the most poorly exposed films made in a department of radiology, since it is almost impossible for the fluoroscopist to gauge, time after time,

the proper exposure factors as the patient is placed first in one position and then in another

Fortunately, the technical problems of spot-film radiography that have just been cited are being solved. Fluoroscopes with fine-focus rotating-anode tubes are now generally available, and fluoroscopes with automatic phototiming on their spot-film devices are being produced by several manufacturers. Spot-film radiography probably constitutes the most valuable of all applications of automatic photo-electric timers. From the moment the switch of the fluoroscope is turned on, these timers permit the fluoroscopist to forget entirely the technical workings of his equipment and to devote his undivided attention to the clinical problems of his patient.

Another factor which frequently leads to poor quality in spot-films is the failure to use a grid when the exposure is made. As we shall see shortly, the use of a grid in conventional fluoroscopy is not so important, but when films are to be obtained, the contrast will be undesirably low unless a grid is employed. Some radiologists object to the grid lines that occur on the films made with conventional stationary grids. It appears likely that moving grids may become available on spot-film equipment before long and eliminate this difficulty. Such a grid has been installed in the fluoroscope shown in Figure 5.

Although fine-focus x-ray tubes and stationary grids have found their greatest usefulness in spot-film radiography, they have been advocated by some for conventional fluoroscopy. The comparative merits of fine-focus tubes over coarse-focus tubes are illustrated in Figure 8, where the smallest image which may be perceived at fluoroscopy is plotted as a function of image contrast. The solid curves are identical with those shown in Figure 7 and represent conditions where disks of essentially perfect sharpness are viewed on fields of varying contrast under the fluoroscopic conditions specified for Figure

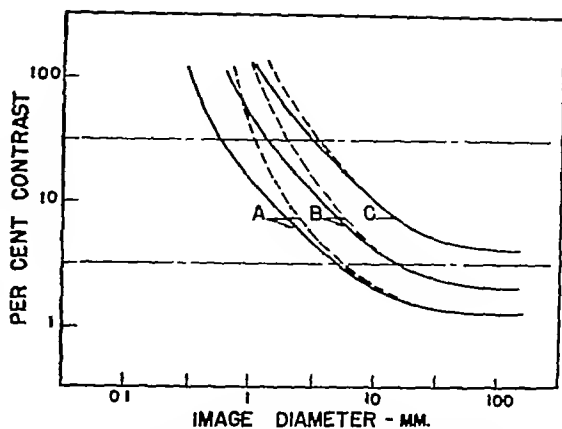


Fig 8 Visual performance curves in which per cent threshold contrast is plotted as a function of minimum perceptible image diameter. Solid curves are identical with those in Figure 7. Dotted curves represent conditions in which the images on the screen are produced by objects placed 20 inches in front of the x-ray tube and 4 inches behind the fluoroscopic screen and examined fluoroscopically with a tube having a focal spot 5 mm in diameter.

7. The dotted curves, on the other hand, represent conditions in which the disks are placed in such a position between the x-ray tube and the fluoroscopic screen that the geometric unsharpness at the image boundaries on the screen is 1 mm (the unsharpness that would be produced by objects examined fluoroscopically with a tube having a 5-mm focal spot and placed 20 inches in front of the x-ray tube and 4 inches behind the screen).

It will be observed that some improvement in vision occurs when the unsharpness caused by the large focal spot is removed. The effect is greatest when the structure under examination is thinnest (*i. e.*, when the screen is brightest). It therefore seems well worth while to use fine-focus tubes for fluoroscopy.

It is well known that grids do not seem as advantageous in fluoroscopy as in radiography. The reason for this may be found in the fact that, although a grid improves the contrast of an image, it also decreases its brightness. The net result, therefore, is not the spectacular change that is seen in radiography. However, it has recently been shown (3) that the improvement in visibility due to the increased contrast provided by a grid is greater than the loss

of visibility due to the decreased screen brightness, and there is therefore no doubt that grids are generally desirable for conventional fluoroscopy.²

* The relationship between the size of the smallest image that can be perceived at fluoroscopy, the contrast of the image and the brightness of the fluoroscopic screen may be expressed by the general equation

$$d = \frac{k}{CB^{1/2}} \quad (1)$$

where d is the image diameter, C is the image contrast, B is the screen brightness, and k is a constant.

Also, the contrast of an image may be defined as

$$C = \frac{\Delta B}{B} \quad (2)$$

where ΔB is the difference in brightness between the image and its surrounding field

Now, in fluoroscopy, if it were possible to prevent all scattered radiation from reaching the screen, let us say by a perfect grid, then the contrast of the image would be

$$C = \frac{\Delta B_p}{B_p} \quad (3)$$

where the subscript p indicates that the light emitted from the screen is due entirely to primary x radiation. If no grid were used, the contrast value would be

$$C_i = \frac{\Delta B_p}{B_i} \quad (4)$$

where the subscript i indicates that the light emitted from the screen is produced by the total radiation products, primary and secondary, transmitted from the patient

It is evident from equations (1), (2), and (3) that the smallest perceptible image that may be seen when a perfect grid is used is given by the equation

$$d_p = \frac{kB_p^{1/2}}{\Delta B_p} \quad (5)$$

Also, when a grid is not used

$$d_i = \frac{kB_i^{1/2}}{\Delta B_p} \quad (6)$$

When equation (5) is divided by equation (6)

$$\frac{d_p}{d_i} = \left(\frac{B_p}{B_i} \right)^{1/2} \quad (7)$$

Since B_p is smaller than B_i , equation (7) indicates that d_p is smaller than d_i , that is, smaller images may be seen when a grid is employed at fluoroscopy than when it is not used. The improvement in visibility is not proportional, however, to the ratio of the screen brightnesses with and without a grid, as it is for radiography, but only proportional to the square root of the ratio. Thus the usefulness of a grid during fluoroscopy is not so apparent as in radiography.

SUMMARY

The discussion of the physical problems of fluoroscopy and spot-film radiography that has been developed in the foregoing pages appears to indicate that the radiation hazards attendant on these procedures may be minimized (a) by maintaining the fields of fluoroscopic observation as small as possible, (b) by keeping the time of fluoroscopy short, (c) by providing 2 to 4 mm of aluminum filtration in the x-ray beam, and (d) by plotting the exposure conditions that exist about one's fluoroscope and introducing such extra protective measures beyond those provided by apron and gloves as may be necessary. In addition, the hazards will be somewhat further reduced by increasing the target-table top distance and increasing the x-ray tube potentials to levels of 85 to 100 kv p. No significant radiation hazard is introduced by the employment of spot-film radiographic techniques in routine fluoroscopic practice.

The problems of poor visibility that exist during fluoroscopy may be solved by the use of spot-film radiography. Full advantage of this procedure, however, can be taken only when a fine-focus rotating-anode x-ray tube, a stationary grid, and an automatic phototimer are used. A grid and a fine-focus x-ray tube also benefit conventional fluoroscopy to an extent sufficient to merit their general use in this field.

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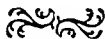
SUMARIO

Problemas Físicos de la Roentgenoscopia y la Radiografía Instantánea

El estudio de los problemas físicos planteados por la fluoroscopia y la radiografía instantánea parece indicar que pueden reducirse a un mínimo los riesgos de la irradiación (a) manteniendo los campos de observación roentgenoscópica lo más pequeños posible, (b) abreviando la duración de la roentgenoscopia, (c) facilitando una filtración del haz de rayos X por 2 a 4 mm de aluminio, y (d) delineando las condiciones de exposición que existen alrededor del roentgenoscopio e introduciendo las providencias extraordinarias de protección que parezcan necesarias, aparte de las ofrecidas por el delantal y los guantes. Los riesgos serán algo atenuados aumentando la distancia desde la porción superior de la

mesa al blanco e igualmente los potenciales de los tubos de rayos X a cifras de 85 a 100 kv p. El empleo de la radiografía instantánea en el curso de la roentgenoscopia no agrega mayor riesgo a la irradiación.

Los problemas creados por la mala visibilidad durante la fluoroscopia pueden ser resueltos con el empleo de la radiografía instantánea, pero para aprovechar plenamente la misma hay que utilizar un tubo de rayos X de ánodo rotatorio y foco fino, una rejilla estacionaria y un fotocronógrafo automático. Una rejilla y un tubo de rayos X de foco fino también benefician la roentgenoscopia corriente lo suficiente para justificar su empleo general en dicho procedimiento.



Gastrosocopy in the Evaluation of Patients with Peptic Ulcer¹

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THE OBJECT of this paper is to discuss the value and limitations of gastrosocopy as a diagnostic aid and as a guide to the efficacy of therapy in patients with duodenal, gastric, and stomal ulcers

A gastrosocopic study may readily be made in fasting patients on an ambulatory basis, with local anesthesia of the pharynx. While the patient lies on his left side, the instrument, which is flexible and covered with rubber in the portion which lies in the lower esophagus and stomach, is inserted. A prism at the distal end enables various areas of the gastric mucosa to be seen at right angles to the axis of the instrument. A series of convex lenses allows a clear image to be maintained if the flexible portion is deviated not more than 30° at any single point. During the procedure the stomach is inflated with air through a passage inside the instrument.

Upon the initial insertion of the gastrosocope, the pylorus should be sought as a major landmark and should be seen in 90 per cent of undistorted stomachs (1). A second landmark, the incisura angularis, is an arch-like fold on the lesser curvature which separates the antrum from the body of the stomach. This fold, caused simply by the angulation of the stomach, corresponds roughly to the incisura demonstrated radiologically. Deep peristaltic waves may be seen to cross the antrum associated with contractions of the pylorus.

Three zones of the stomach are not visible gastrosocopically: the posterior wall on which the instrument lies, the lowermost lesser curvature behind the incisura angularis, and the cardiac portion of the stomach which domes above the entrance of the esophagus. No portion

of the esophagus can be seen gastrosocopically. Radiographic studies made by Ould and Dailey (2) demonstrated that the gastrosocope clings closely to the posterior wall near the lesser curvature. This is the reason why it is frequently difficult or impossible to visualize lesions of the posterior wall, since the focal distance of the lens of the instrument is approximately 15 cm.

The contraindications to gastrosocopy include esophageal diverticula, varices, and neoplasms, cardiospasm, aortic aneurysm, severe deformities of the thoracic spine, gastric tumors which encroach upon the cardia. Age is not a contraindication, our oldest patient being eighty-six years of age. Nearly all patients are entirely cooperative when the procedure is explained to them and they are assured of the absence of pain.

Several studies have been made which compare the accuracy and relative value of competent radiographic and gastrosocopic examination of the stomach, that of Benedict (3) is one of the most recent, objective, and comprehensive appraisals. Since a major gain from gastrosocopy is the evaluation of radiographic findings, it is evident that an appreciation of the value and limitations of each method of examination is desirable. Only on rare occasions is gastrosocopy performed prior to barium examination, and it is the radiologist, therefore, who informs the gastrosocopist as to the sites of various lesions and where the major portion of the examining time should be spent. Gastrosocopy and radiography of the stomach are methods which nicely complement each other, the former enabling one to see large areas of mucosa in

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detail and the latter to discover abnormalities of contour, pliability, or peristalsis, and to identify lesions in areas inaccessible to the gastroscope

DUODENAL ULCER

In our experience gastritis associated with uncomplicated duodenal ulcer is not common, although Christiansen (4) reported an incidence of 61.4 per cent in 70 patients. In our series of 107 patients with duodenal ulcer the gastric mucosa was entirely normal in 82 (Table I). An

TABLE I APPEARANCE OF GASTRIC MUCOSA IN 107 PATIENTS WITH DUODENAL ULCER

Normal gastric mucosa	82*
Hyperfunctioning mucosa	18
Superficial gastritis	2
Hypertrophic gastritis	1
Atrophic gastritis	1
Mucosal hemorrhages	1
Gastric ulcer benign	2

* Three with pyloric displacement due to posterior penetrating duodenal ulcer

additional 18 patients displayed an engorged hyperemic mucosa with soft enlarged succulent rugae. This is considered to be a purely physiologic change associated with the gastric hypersecretion so common in these patients. Wolf and Wolff (5) have noted this hyperfunctioning mucosa by observations through a gastrostomy stoma. Their subject was without gastrointestinal disease. Emotions such as resentment and drugs such as alcohol or histamine produced a hyperemic edematous mucosa which seems identical in appearance with the hyperfunctioning mucosa noted in our patients with duodenal ulcer. In this way, a gastritis is simulated but is obviously not present, since the hyperemia is transient, there is no thick adherent mucus, and the rugae are simply edematous with no evidence of gastritic infiltration. If such a hyperfunctioning mucosa occurs in patients with duodenal ulcer, and gastrectomy is contemplated, an especially high resection is indicated. In posterior penetrating duodenal ulcers, the pylorus may be displaced posteriorly, while with obstruction, minimal inflammatory changes may be present, appar-

ently due to the retained acid secretion.

Gastroscopy is also useful in certain patients with duodenal ulcers complicated by obstruction or bleeding. Since it is sometimes difficult to determine if gastric retention is due to a duodenal or antral lesion, gastroscopic visualization of a normal pylorus would support strongly the inference that the obstruction is extragastric and probably due to a cicatrizing duodenal ulcer. In instances of shallow duodenal ulcers, bleeding intermittently and perhaps not too clearly identified radiologically, a normal gastroscopic examination would aid in ruling out gastric disease as the cause of bleeding. This may be of real significance especially if surgery is planned in a period of quiescence between hemorrhages.

GASTRIC ULCER

All patients with gastric ulcer should be examined gastroscopically if possible. The relationship of persistent gastric ulcer to cancer is fully appreciated by radiologists. It is most important not to theorize as to whether a benign ulcer will become malignant, but to admit that a gastric ulcer which fails to heal promptly should be resected.

Unfortunately, many gastric ulcers are in zones which cannot be visualized gastroscopically. Of 88 ulcers demonstrated radiographically within the previous month, 52 (59.0 per cent) were seen gastroscopically. The remainder were situated in gastroscopic blind areas or perhaps hidden by secretions or healed. Three additional ulcers were discovered, which had not been recognized radiographically. These were located high in the stomach, so that the ribs made adequate palpation during fluoroscopy impossible.

At gastroscopy the typical benign gastric ulcer has a punched-out appearance, with a gray fibrin base. If it is chronic, the walls may be thickened and elevated but nevertheless rather sharply demarcated from the surrounding normal mucosa. The wall of a carcinomatous ulcer may be expected to blend with the adjacent mu-

Gastrosocopy in the Evaluation of Patients with Peptic Ulcer¹

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TABLE III
APPEARANCE OF GASTRIC MUCOSA IN
41 POSTOPERATIVE STOMACHS

Normal gastric mucosa	29
Superficial gastritis	7
Atrophic gastritis	2
Mucosal hemorrhages	1
Marginal ulcer	1
Jejunitis	1

graphically, but only one of these was visualized at gastroscopy. In 7 instances a bona fide gastritis was present with thick tenacious mucus adherent to the inflamed mucosa. Severe jejunitis was found in one patient with long-standing melena.

GASTRITIS

A complete discussion of gastritis and its clinical significance is not pertinent to this paper. It may be stated, however, that when clinical response to adequate therapy of peptic ulcer is poor, gastroscopy may reveal an associated gastritis as the cause of unrelieved symptoms. In a few instances, not reported here, an antral gastritis was present, associated with shallow erosions, which had been suspected radiographically. Such a type of gastritis may give pain indistinguishable from that of peptic ulcer, although more frequently the symptoms are due to a gradually developing obstruction.

SUMMARY AND CONCLUSIONS

1. Gastroscopy is of diagnostic aid in ruling out associated gastric disease when

duodenal ulcers are suspected of causing chronic bleeding or obstruction, or when response to therapy is poor.

2. Benign gastric ulcers may be rather accurately differentiated by gastroscopy from malignant ulcers, but proof of benignity of an individual gastric ulcer is establishment, by gastroscopic examination, of absolute healing.

3. Significant gastritis or jejunitis may be found gastroscopically in postoperative stomachs when no roentgenologic signs of disease are evident.

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SUMARIO

La Gastroscopia en la Valuación de los Enfermos con Úlcera Péptica

La gastroscopia y la radiografía gástrica son métodos que se complementan perfectamente, capacitando la primera para observar grandes zonas de mucosa en detalle y revelando la segunda anomalías de contorno, flexibilidad o peristaltismo a la vez que mostrando lesiones en zonas inaccesibles al gastroscopio.

La gastroscopia ayuda en el diagnóstico por excluir la presencia de gastropatía asociada cuando se sospecha que úlceras duodenales ocasionan hemorragia u oclu-

sión crónica o cuando la respuesta a la terapéutica es mala.

Con la gastroscopia pueden diferenciarse con bastante exactitud las úlceras gástricas benignas, de las malignas, pero la prueba de la benignidad de una úlcera gástrica dada consiste en el establecimiento gastroscópico de la cicatrización absoluta.

Gastroscópicamente, pueden descubrirse significativas gastritis o yeyunitis postoperatorias en estómagos sin signos roentgenológicos de enfermedad.

Peptic Ulcer

Modern Criteria for Diagnosis and Attempted Diagnosis of Healing¹

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RADIOLOGISTS so commonly deal with objective data regarding the appearance of the stomach and duodenum fluoroscopically or on films that they are apt to lose sight of the importance of the subjective data which the clinician can bring to bear on problems related to the diagnosis of peptic ulcer or its healing. It would perhaps be of advantage to discuss with you the clinician's point of view in regard to the light thrown upon these problems by the subjective clinical data he obtains from a patient and his interpretation of the objective information furnished him by the radiologist.

The usefulness of such a discussion is apparent, for peptic ulcer is an extremely common and important disease. Sandweiss (10), in 1947, in a summary for the National Committee of the American Gastroenterological Association for the Study of Peptic Ulcer, pointed out that physicians in the United States see more than 361,000 patients a month with this condition, and estimates indicate that there are approximately one and a half million persons in this country above the age of thirty in whom peptic ulcer develops during a period of ten years. Physicians in the Armed Forces during World War II were greatly impressed by the frequency of the disease. Sandweiss quotes figures from the respective Surgeons General to the effect that during the years 1942 through 1944 for the Army and 1942 through 1945 for the Navy the number of men separated from the services for disability due to this cause exceeded 48,000, or the equivalent of at least four infantry divisions. Furthermore, its medical and

financial importance as a cause of disability among veterans is indicated by studies such as those of Hussar (8). Finally, emphasis should be placed on the importance of a diagnosis of peptic ulcer among those persons in civilian life who may temporarily fail to secure life insurance or who receive disability payments on this account.

CLINICAL DIAGNOSIS

As Eusterman (5) has pointed out, few lesions give rise to such typical symptoms as do uncomplicated gastric and duodenal ulcers. All of us are familiar with the pain-food-ease rhythm of uncomplicated ulcer and with the typical pain, which is chronic, periodic, usually gnawing or aching in character, and promptly relieved by ingestion of food. The two factors which strike the experienced clinician as being the most useful and certain in clinical diagnosis are (a) the regular occurrence of pain, distress, or related symptoms, synchronous with some phase of the digestive cycle, usually one or more hours after eating, and (b) the periodic occurrence of these symptoms, with alternating episodes of distress and relief for weeks or months, often without apparent cause. Of secondary diagnostic value are the location of the pain in an area between the neck and the testicle, the nature of the pain, its relief by ingestion of food or by antacids, and the associated symptoms of heartburn, belching, and gas.

How often can one obtain this "typical" history of ulcer? The more experienced the clinician, the more frequently will he, by careful questioning, elicit such a his-

¹ From the Stanford University School of Medicine and the University of California Medical School. Presented as part of a Symposium on Peptic Ulcer at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5-10, 1948.

tory It is to be found in 80 to 95 per cent of all patients with active uncomplicated peptic ulcer When there is associated gastro-intestinal bleeding, the clinical diagnosis of ulcer in the stomach or duodenum is established

Attention should also be called to other clinical syndromes which may be encountered in patients with ulcer (Table I) Briefly, an "atypical ulcer" story is not frequent and, as Eusterman (4) has stated, in many instances its apparent occurrence is the result of incomplete or inaccurate information The features of such an "atypical ulcer" history include frequent occurrence of pain within fifteen to thirty minutes after eating, incomplete or delayed (fifteen to thirty minutes) relief of pain by ingestion of food or antacid, absence of clear-cut episodes of distress and freedom from distress, late awakening with night pain (3 to 5 A M), epigastric distress on awakening, and associated general and gastro-intestinal psychoneurotic manifestations This type of history is noted more frequently in patients with gastric than with duodenal ulceration, and it may well be the result, in part or in whole, of associated disease in other organs or of "functional disturbances" accompanying the ulcer

Acute perforation or gastro-intestinal bleeding without antecedent symptoms of ulcer and, in the case of bleeding, without subsequent indigestion, may be the only clinical manifestation of an active peptic ulcer Or the sole clinical evidence may consist in symptoms of other complications, such as penetration or obstruction of the pylorus, particularly in patients of the hyposensitive type Finally, and infrequently, the only clinical manifestation may be pain of a crisis type or vomiting, much like that observed in the crises of tabes dorsalis

Chronic dyspeptic symptoms, such as gaseous indigestion, cramping abdominal pains, abdominal distention, belching, and aerophagia are comparatively rare in cases of simple ulcer, as has been pointed out by Bockus (2) On the other hand, a "typi-

TABLE I CLINICAL FEATURES OF ULCERS

Manifestations	Features
Typical history	Pain (a) Synchronous with digestive cycle (b) Occurring periodically (c) Chronic (d) Special qualities
Atypical history	Lack of clear-cut ulcer features (see text)
Symptoms of complications (a) Hemorrhage (b) Perforation (c) Obstruction	Often absent or minimal antecedent dyspepsia
Crisis type	Vomiting Pain

cal ulcer story" may occasionally be obtained from patients with carcinoma of the stomach, cholecystic disease, chronic pancreatitis, carcinoma of the pancreas, or hookworm infection Usually the skilled clinician can find in the patient's history evidence to lead him to suspect a lesion other than ulcer The so-called "pseudo-ulcer" or "atypical ulcer" story is much more commonly given by patients with psychoneuroses than by patients with ulcer

Other clinical data, including those obtained on physical examination, gastric analysis, or other laboratory tests, generally are not of much value in the diagnosis of uncomplicated peptic ulcer, although they may be of help in the occasional case

The clinical diagnosis depends, in brief, on the history the patient gives, and in cases difficult to diagnose, considerable skill may be required of the clinician to approach the patient properly and to elicit a true account of his symptoms

RADIOLOGIC DIAGNOSIS

It is generally accepted that the radiologic method of diagnosis of peptic ulcer is 95 per cent accurate A crater or niche is the only definite x-ray evidence of an active ulcer It is reported to be found in approximately 90 per cent of patients with gastric ulcer and in from 30 to 70 per cent of cases of duodenal ulcer The variability in results depends in large part on the technic of examination In a considerable

number of cases of active ulcer a crater will not be demonstrable and furthermore a niche has at times been reported in the stomach or duodenum when examination within the next few days, at gastroscopy, at operation, or at necropsy, has failed to reveal an active ulcer

Constant duodenal deformity in the absence of a previous upper abdominal operation generally is considered to be evidence of an active or healed duodenal ulcer and as such is said to be from 90 to 95 per cent accurate. Other less convincing and suggestive evidence of duodenal ulcer includes irritability, spasm and fragmentation of the duodenal cap, and edema of or striking alteration in the appearance of the duodenal or gastric mucosa. Most of the errors that are made in the radiologic diagnosis of peptic ulcer are those of omission and not of commission.

CORRELATION OF CLINICAL AND RADIOLOGIC DIAGNOSIS

In making a diagnosis of peptic ulcer, the roentgenologic evidence must be weighed and its value assessed by the clinician in conjunction with the other data available. As Eusterman (5) has well expressed it, "the case history, in the absence of skilled fluoroscopy, is all-essential, and is much more important than unskilled examination by fluoroscopy alone."

Perhaps most often for his own reassurance and that of the patient, the clinician will request radiologic examination to rule out an intrinsic organic lesion in the upper gastro-intestinal tract in the presence of digestive symptoms of uncertain nature. In performing this function the clinician leans heavily upon the well trained radiologist.

In determining the activity of a duodenal ulcer, the experienced clinician will much more often rely on absence of symptoms than he will on the radiologist's report. If the patient is symptom-free, disappearance of a previously known crater substantiates the evidence of healing. However, if duodenal deformity persists,

the clinician knows that the radiological examination is not helpful in telling him whether an ulcer is active or inactive.

Garland (7) has presented a very good outline of the report which the radiologist might give the clinician on patients referred for roentgen examination for evidence of duodenal ulcer, namely (1) duodenal ulcer with visible crater, (2) duodenal ulcer with questionable crater, (3) duodenal ulcer with no crater visible but deformity, typical, presumably active, (4) duodenal bulb deformity, probably scarring from healed ulcer, (5) duodenal bulb deformity probably surgical (closure), perforated ulcer, etc., (6) duodenal bulb deformity, probably extrinsic (no ulcer), (7) negative.

It is suggested that this classification might be modified so that Item 5 would read "duodenal bulb deformity with pyloric obstruction and/or gastric retention," omitting any reference to the therapeutic indications.

While a classification of this type is very useful for purposes of study, it must be recalled that, without anatomic proof of the exact appearance of the duodenal mucosa, these findings must in large part be interpreted by the clinician in terms of the patient's symptoms and the clinical findings, and that they are therefore of relative and not absolute value. Use of such a classification by a radiologist in conjunction with several carefully trained clinicians would, over a period of five or ten years, add considerably to the diagnostic accuracy of each group, and above all would lead to more information for each of them.

When the radiologist reports findings in agreement with the clinician's impressions of the diagnosis, the diagnosis is established. When there is a discrepancy, however, between the clinical and radiological findings, the clinician will be influenced in his diagnosis by such factors as (1) the character of the patient's complaints and their resemblance to the symptoms of ulcer, (2) the certainty of his clinical impressions of ulcer, (3) his past experience

TABLE II CORRELATION OF CLINICAL AND RADIOLOGICAL DATA IN DIAGNOSIS OF ULCER

Method of Diagnosis	Value of Signs				
	Absolute	Definite	Relative	Questionable	
Clinical	95 per cent Pain synchronous Periodicity	85-90 per cent Ulcer type of distress	75-85 per cent Dyspepsia suggestive of ulcer	No distress or vague distress	50-60 per cent Ulcer type distress
Radiologic	Niche	Persistent duodenal deformity	Fragmentation of cap Various defects, spasm, irritability, etc	Duodenal deformity	Normal duodenum

with the accuracy of reports from the radiologist who examined the patient, and (4) the presence of other evidences of organic disease

In Table II an attempt has been made to set down those clinical and radiologic data which would be considered to have absolute, definite, relative, and questionable value in the diagnosis of ulcer

In a patient with clinical evidence or a "typical history" of ulcer, with or without bleeding, and a radiologically demonstrable niche in the stomach or duodenum, the diagnosis of ulcer would be established (with the exception of ulcerating neoplasm in the stomach) In fact, with either of these clinical or radiologic findings alone, the diagnosis of ulcer could be made and be accepted unless some very unusual mitigating circumstances pointed strongly to another condition Furthermore (in a patient with ulcer type of distress) with a constantly deformed duodenal cap the diagnosis of duodenal ulcer would be established These findings would have definite value (Table II) In a case, however, in which the dyspepsia was suggestive of ulcer and the radiologic examination indicated variable deformity, spasm, irritability, or fragmentation of the duodenal cap, these latter findings would be relative only and the physician (to come to a correct decision) would have to be guided by his clinical judgment, by the subsequent clinical course, and subsequent radiological appearance of the duodenal bulb

In a rather large and important group of cases there is conflict between the clinical and radiologic data For example, the patient may have no history, or a very

vague one, of dyspepsia, and yet show a constant duodenal deformity, or, conversely, the patient may give a classical story of ulcer while the stomach and duodenum appear normal radiologically In this group of puzzling cases, all sorts of variations may be noted, in the clinical range of "no symptoms" to "those of ulcer" and in the radiologic range from "a normal stomach and duodenum" to a "constant deformity or niche"

Too often, in his effort to cover himself, the radiologist will report changes in the mucosa of the stomach or duodenum which could or could not be interpreted to mean ulcer These changes include edema of the mucosal folds, irregularity of the folds, or a "drop" of barium pent up between them While such findings should be accurately recorded, too often they are interpreted by the radiologist as perhaps those of ulcer or they are looked upon by the clinician and even by the patient as significant of disease When radiologic findings of an indefinite nature are made, the clinical findings and the results of subsequent radiologic examinations should be given most weight

How is such a situation to be resolved for the clinician and his patient? The only courses open are (1) further roentgenologic study by the same or another radiologist, (2) observation of the patient under treatment, with subsequent radiologic examination, (3) gastroscopy in case of a suspected lesion in the stomach, (4) operation

Further Radiologic Study At times it is unfortunate that in cases of peptic ulcer the clinical data are based largely on the

In the case of gastric ulcer, the radiologist can usually determine healing very accurately by observing disappearance of the niche. Only occasionally will the gastroscopist find an active gastric ulcer when the radiologist reports it to be healed, although not infrequently the gastroscopist will find an ulcer incompletely healed when the niche is no longer visible on radiologic examination.

For duodenal ulcer the radiologic evidence of healing is less convincing. Disappearance of a niche in the duodenal bulb may be considered as evidence of healing, and it has been so used in studies such as those of Cummins, Grossman and Ivy (3) on the "healing" time of ulcer. If, in addition to disappearance of the niche, there is disappearance of the duodenal deformity, the radiologic criteria for healing are complete and convincing (Garland, 7). However, Feldman (6) has correctly pointed out that disappearance of the niche cannot always be relied on as a sign of complete healing. Other observers, such as Jordan (9), consider fluoroscopy the best aid in distinguishing active from quiescent ulcer, since rapid filling and emptying and spasm (of the bulb) are so characteristic of the active phase.

During the war, extensive and frequent radiologic examinations of young men with duodenal ulcers of short duration indicated very definitely that complete restitution of the duodenal cap to normal may occur following treatment. This observation is in conflict with the often expressed view that once a duodenal ulcer has been present the bulb never again becomes smooth or normal in contour.

Weir (11) well expressed the average clinician's view of the radiologist's capacity to determine healing of duodenal ulcer when he stated: "However, because roentgenologic diagnosis of duodenal ulcer depends on the persistent deformity of the cap, craters are demonstrable in only 20 to 40 per cent of cases, and because this deformity usually persists after healing, there remains no satisfactory roentgenologic finding by which the activity, inactiv-

ity, or healing state of duodenal ulcer can be determined." Similarly Garland (7) has indicated, in summary, that in average circumstances the reliability of x-ray examination in determining healing of duodenal ulcer is probably only 50 per cent.

Consequently, it seems reasonable to conclude that when, in a case of duodenal ulcer, a once visible crater disappears following therapy and the patient becomes free of symptoms, healing has occurred. If, in addition, the duodenum has again become normal, the evidence is even better. Many clinicians in such cases would be skeptical of the original roentgen findings and diagnosis. In the absence of a crater, the radiologist can produce almost no evidence of the healed or active state of an ulcer in the duodenum.

Information Which the Clinician Expects from the Radiologist In the diagnosis of peptic ulcer, the clinician always feels most satisfied when the clinical and radiologic data are in agreement. Therefore, in the patient suspected of having an ulcer, the clinician expects information (1) as to the presence or absence of ulcer, (2) as to whether or not the ulcer is healed or active, (3) as to the location of the ulcer—gastric, duodenal, or jejunal, (4) as to the presence or absence of obstruction, and, if gastric retention is present, whether it is due to actual obstruction, spasm, edema or scar tissue or to gastric atony, (5) as to the size of the ulcer, (6) as to its shallow or penetrating character, (7) in the case of a gastric lesion whether or not it is malignant.

CLINICAL INTERPRETATION OF RADIOLOGIC STUDIES OF THE UPPER GASTRO-INTESTINAL TRACT

How much attention does the clinician practising internal medicine pay to radiologic studies of the upper gastro-intestinal tract and why does he have such studies made?

In an effort to come to some opinion regarding this matter, a review has been made of 200 consecutive cases in which such studies were done by radiologists for

a group of physicians practising together in the same office. No conclusions can be drawn from such a study, as the series is small, and in only a few cases was either the clinical or the radiological diagnosis actually confirmed by anatomic or pathologic study of the stomach and duodenum. The results, recorded in Tables IV and V, are striking and require some explanation.

TABLE IV UPPER GASTRO INTESTINAL RADIOLOGIC STUDIES IN 200 CONSECUTIVE CASES ANALYSIS OF CLINICAL INDICATIONS FOR RADIOLOGIC STUDY

	Cases
'Ulcer story'	41
Dyspepsia	54
Vague abdominal symptoms	70
Reassurance to patient	6
Other	29
TOTAL	200

In 4 cases the radiologic diagnosis of gastric ulcer was not concurred in by the clinician in his final diagnosis because the clinical evidence of ulcer was insufficient and he did not consider the radiologic findings convincing. The final outcome in these 4 cases is not known. In 4 cases the radiologist's diagnosis of gastric ulcer was accepted. In 11 cases in which the radiologist reported finding a duodenal ulcer the clinician did not accept the diagnosis because of insufficient clinical evidence in 8, lack of free hydrochloric acid in the gastric juice (after stimulation with histamine) in 1, and for unknown reasons in 2 cases.

In 3 cases in which a final diagnosis of carcinoma of the stomach was made the radiologic diagnosis of carcinoma was definite in one case only. In a second case the radiologic diagnosis was "probably

scarring on lesser curvature (healed ulcer?)," the preoperative clinical diagnosis was questionable neoplasm of the stomach, and operation revealed an inoperable carcinoma of limitis plastica type. In a third case, that of a woman of thirty-eight with a brief history typical of ulcer, the original radiologic study revealed irregularity and swelling of the mucosal folds in the duodenal bulb, without evidence of an ulcer crater. Fifteen months later two radiological studies within a ten-day period revealed gastric retention and pyloric obstruction apparently due to spasm. A month later pyloric obstruction persisted and the radiologist reported "may be ulcer, neoplasm to be strongly considered." Free hydrochloric acid of well over 100 clinical units was present, a clinical diagnosis of duodenal ulcer with obstruction was made, and at operation an ulcer crater in the stomach was found, at the base of which evidence of carcinoma was disclosed by microscopic study (lymph nodes were involved also).

It is interesting to note what interpretation the clinician placed on the radiologist's report of "irritability" or inflammatory changes in the stomach or duodenum (usually the latter) (Table IV, 32 cases). A final clinical diagnosis of gastric and duodenal ulcer was not made in any of these cases, carcinoma of the stomach was diagnosed in 2 cases, "functional" gastro-intestinal diseases in 14 cases, anxiety tension states in 9 cases, and other non-gastro-intestinal disease in 7 cases. It is worthy of comment that in about half the cases referred for radiologic study the roentgenologist reported normal findings.

TABLE V UPPER GASTRO INTESTINAL RADIOLOGICAL STUDIES IN 200 CONSECUTIVE CLINICAL CASES

Radiological Diagnosis		Final Clinical Diagnosis	
	Cases		Cases
Gastric ulcer	8	Gastric ulcer	4
Duodenal ulcer	43	Duodenal ulcer	32
Tumor of stomach	1	Carcinoma of stomach	3
'Irritability' or inflammatory changes	32	'Functional' gastro intestinal tract disease	46
Other (including varices, hernia, duodenal polyp subtotal gastric resection etc)	15	Anxiety—Nervous exhaustion	51
Normal	101	Other gastro-intestinal tract diagnoses	64
TOTAL	200	TOTAL	200

DWIGHT L. WILBUR AND MALCOLM S. M. WATTS

TABLE VI RADIOLOGIC DIAGNOSES IN 200 CASES CLASSIFIED ACCORDING TO CLINICAL INDICATIONS FOR RADIOLOGIC STUDY

Clinical Indications	No of Cases	Radiologic Diagnoses				
		Gastric Ulcer	Duodenal Ulcer	Carcinoma Stomach	Irritability or Inflammatory	Other
Ulcer story	41	4	24	1	7	2
"Dyspepsia"	54	2	7	0	9	6
Vague gastro-intestinal symptoms	70	2	8	0	10	2
Reassurance	6	0	1	0	0	0
Other	29	0	3	0	0	5
						3
						30
						48
						5
						16

It is of some interest to note the clinical indications which led the internist to request radiologic study in these 200 cases (Table V). Under "dyspepsia" are included patients complaining of "gas," upper abdominal discomfort or distress, belching, heartburn, nausea or vomiting related to eating but without the features of an "ulcer story" previously noted. "Vague abdominal symptoms" include abdominal complaints not clearly related to ingestion of food, this group, however, cannot be sharply separated from the group with dyspepsia. The term "other" covers patients with complaints or previous findings of "gas," diarrhea, constipation, anemia, hiatal hernia, black stools, achlorhydria, motion sickness, migraine, and so forth. The results of radiological studies in these various groups of patients are noted in Table VI.

The observations which can be made from this small series of cases are that the radiologist made the diagnosis of gastric and duodenal ulcer more frequently than the clinician was willing to accept it, that when the radiologist reported irritability or inflammatory change in the stomach or duodenum, a diagnosis of ulcer was not made clinically in a single instance, and that when a clinical history typical of ulcer was present the radiologist made a diagnosis of gastric or duodenal ulcer in 28 of 41 cases and reported findings of a normal stomach and duodenum in only 3. While these observations are interesting, no final conclusions can be drawn from them in view of the selective character of the cases and, as pointed out above, the lack of anatomic diagnoses.

Certainly closer co-operation is needed

between radiologist and clinician in the study of patients in whom there is a discrepancy in findings, and further studies should be carried out.

SUMMARY

The clinical diagnosis of peptic ulcer depends upon the history given by the patient. The so-called "typical history" is present and is diagnostically accurate in 80 to 95 per cent of all cases. In others there may be an "atypical" story, the symptoms may be due to complications, or there may be pain or vomiting of the crisis type.

Radiologic diagnosis, which is said to be 95 per cent accurate, depends largely on demonstration of a gastric or duodenal niche or constant deformity of the duodenum.

When there is a discrepancy between the clinical and radiologic findings the clinician will be influenced in his diagnosis by such factors as (1) the character of the patient's complaints and their resemblance to the symptoms of ulcer, (2) the certainty of his clinical impression of ulcer, (3) his past experience as to the accuracy of reports from the radiologist who examined the patient, (4) the presence of other evidence of organic disease, (5) the results of subsequent clinical and radiologic observations of the patient.

There is no satisfactory clinical evidence of healing of an ulcer. Persistence of symptoms probably means activity of the lesion, but the reverse does not hold. Radiologic evidence for healing is unsatisfactory, also, although disappearance of the niche and the occasional return of the

duodenal bulb to normal probably indicate healing

Interesting but inconclusive observations were made in correlating the findings in 200 consecutive cases in which clinical and radiologic studies of the upper gastrointestinal tract were done

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SUMARIO

Úlcera Péptica Modernas Pautas para su Diagnóstico y para Tratar de Diagnosticar su Curación

El diagnóstico clínico de la úlcera péptica se basa en los antecedentes comunicados por el enfermo, pues hay presente la llamada "típica historia," que resulta diagnósticamente exacta en 80 a 95 por ciento de todos los casos. En otros, la historia puede ser "atípica," los síntomas pueden deberse a complicaciones, o puede haber dolor o vómitos del tipo crítico.

El diagnóstico radiológico, que pasa por alcanzar una exactitud de 95 por ciento, se basa en gran parte en el hallazgo de un nicho gástrico o duodenal o de deformidad constante del duodeno.

Si discrepan los hallazgos clínicos y radiológicos, el clínico considerará en su diagnóstico factores tales como (1) naturaleza de los síntomas y semejanza a los producidos por úlcera, (2) certeza de su impresión clínica de úlcera, (3) exactitud de los informes suministrados en el pasado

por el radiólogo que examinó al paciente, (4) presencia de otros signos de afección orgánica, (5) resultados de las subsiguientes observaciones clínicas y radiológicas del enfermo.

No hay signos clínicos satisfactorios de la cicatrización de una úlcera. La persistencia de los síntomas denota probablemente actividad de la lesión, pero lo contrario no es siempre cierto. Los datos radiológicos de cicatrización tampoco son satisfactorios, aunque probablemente la indican la desaparición del nicho y el retorno ocasional del bulbo duodenal a lo normal.

Fueron interesantes, pero no terminantes, las observaciones realizadas al correlacionar los hallazgos en 200 casos consecutivos en los que se ejecutaron estudios clínicos y radiológicos de la porción superior del tracto gastrointestinal.

(For discussion of papers in preceding symposium on Peptic Ulcer, see following page)

DISCUSSION

(Papers by Templeton, Harris, Morgan, Dailey, Wilbur and Watts)

Merrill C Sosman, M D (Boston, Mass)
It has been a pleasure to be here and listen to this Symposium. There does seem to be a little controversy—Templeton *vs* Harris—but I believe that can be resolved historically. In my thirty years of experience, I think that the stages of gastro-intestinal examination can be laid out pretty definitely. Originally, it was mostly by films alone, as exemplified particularly by Lewis Gregory Cole of New York. The second stage was fluoroscopy, represented by Russell Carman and popularized by him, employed at times, unfortunately, in some clinics, without any films at all. The third stage (which most of us are in at the moment) is the use of fluoroscopy to locate the condition and spot films to identify it, and I think that Dr Templeton was advocating that we go into the fourth stage—that of making routine spot films in all parts of the gastro-intestinal tract under examination, in addition to the regular films and the complete fluoroscopic study. If that is true, Dr Templeton, I would like you to tell us exactly what you want us to do in the way of more numerous spot films and examinations. Are you going to take these for every patient, or only for those who have a positive history or some evidence of definite disease? Are you going to take them in a partly filled stomach? In an upright, prone, supine, or lateral position? It would make a tremendous amount of work out of one single examination if you wanted to do it thoroughly. I would like a detailed plan of what you recommend.

I think that most of us modify our examinations, depending either on the patient's symptoms, on the history (which is either sent to us with the patient or which we must take ourselves), or, finally, on what we see during fluoroscopy. We cannot repeat exactly the same examination in each individual case. We have to modify it depending on what we hear, or what we suspect, or what we see.

Now, for the second paper—Harris *vs* Templeton. I think that Dr Harris has an excellent technic in fluoroscopy, but it is absolutely impossible to tell how many cases he has missed. He does not have the spot films to show us and prove to us that lesions were absent in those individual cases. Unless every one of those cases was also examined by Dr Templeton, using the spot-film technic, and all of Dr Templeton's cases were re-examined by Dr Harris without spot films, I don't know where we stand. I would like to have those two get up and fight it out together.

The determination of activity in duodenal ulcer by the spot film technic is impossible, I think, in 15 to 20 per cent of the individuals, either the

duodenal cap is too high above the rib margin, or it is difficult to get satisfactory compression, or the abdominal wall is too thick and muscular for adequate study. Therefore, there would be a group of patients—15 to 20 per cent—in whom a duodenal ulcer could not be ruled out, because, in certain individuals, there is an active duodenal ulcer with no deformity of the bulb. In my experience, that occurs almost entirely in young people with a short history of gastro-intestinal disability, and this history is often typical, as Dr Wilbur has said. When those ulcers heal, they are apt to heal entirely. They have no deformity to start with, so the ulcer will disappear and the cap will be perfectly normal unless there is a recurrent ulcer.

Another point, Dr Harris, is your mention of antispasmodics. That seems to be in all the books. I am afraid that it is even in Dr Templeton's book. From my own experience, I think that the use of antispasmodics is a lot of hooey. I don't believe that they do a single bit of good. I have not seen any evidence of a patient being helped by them. I get much more benefit from simple re-examination of the patient fifteen minutes after he has relaxed in the waiting room while I am examining another patient. I think that is much more beneficial than a barrel full of antispasmodics.

Dr Morgan has presented a beautiful paper, but one certainly needs to read it in detail and study it carefully in order to appreciate it thoroughly. Here are facts—not just opinions. I certainly would agree that an automatic timer which records the duration of fluoroscopy should be an essential part of every fluoroscope and that the time of fluoroscopy should be recorded on the patient's chart. We all agree that a small aperture—just enough to see the part that we are looking at—is important. The new bright fluoroscopic screen allows us to cut down the milliamperage, which in turn reduces the radiation hazard to the patient and also to the observer. I am going right back home and put lead-rubber aprons on the edge of the screen, such as those used with the new, heavy, cumbersome fluoroscopes to which Dr Harris objected. I am referring to the little flexible rubber apron which will cover up the area between the screen and the top of the table. This can be put at the end of the screen when we are doing horizontal fluoroscopy and can be swung to the bottom when we are doing upright fluoroscopy to cover that area between the screen itself and either the top of the apron or the top of the lead-backed chair. The amount of scattered radiation around the edge of the fluoroscope is rather alarming.

Dr Morgan's facts as to visibility should re-

solve the argument between Dr Harris and Dr Templeton, as they are certainly in favor of multiple films taken in different positions and with different degrees of filling. I am very glad to see that the hazard from spot films is much exaggerated. I know you all noticed the statement that one could take six spot films with only about a fifth of the exposure involved in five minutes of fluoroscopy. I have repeatedly told my residents that they cannot make a good diagnosis without good films. That is one of the first essentials, and good spot films certainly are essential in gastro-intestinal diagnosis.

We agree entirely with Dr Dailey that gastroscopy supplements x-ray examination and is not in competition with it. I am very glad to hear you express that point of view, Dr Dailey. The gastroscopist can show superficial erosions and definite gastritis which we cannot diagnose either by fluoroscopy or by any number of films. It is also quite valuable in demonstrating the healing of an ulcer as well as in forming an opinion (not necessarily a fact) as to whether an ulcer is malignant or benign when we are in doubt following an x-ray examination.

In my experience, practically every duodenal ulcer which is chronic is associated with thick, tortuous, gastric mucosal folds. I have been in the habit of calling these "gastritis," but since we have had a good gastroscopist, I have realized my mistake. I am sure that, as Dr Dailey has pointed out, they are purely edema of the mucosa. Therefore, we now limit the diagnosis of "gastritis" to those patients who not only have long, thick, tortuous rugae, but also evidence of hypersecretion, and I think that the combination of big rugae and fluid comes out almost 90 or 95 per cent in accord with the gastroscopic findings. Usually patients with gastric hyperacidity show the same thick edematous mucosa, but in only a few cases is there enough actual inflammation to be called gastritis. On the whole, the size of the gastric rugae, to me, has been a pretty good index of the degree of hyperacidity, the higher the acidity, the greater the edema of the gastric mucosa. I would like to have Dr Dailey and Dr Wilbur comment on that if they will.

Dr Wilbur, unfortunately, did not have sufficient time to read his entire paper. However, the paper will be published, and I recommend that you read it in detail. It gives the clinician's idea as to what the radiologist should furnish him. My own experience in one year of consecutive gastro-intestinal examinations covering about 1,500 cases showed that exactly one out of four patients had duodenal ulcers, 50 per cent of the patients with sufficient symptoms to justify an x-ray examination were entirely negative. Autopsy findings, with careful study of the duodenal bulb, have shown that 10 per cent of all people have duodenal ulcer. Therefore, in this audience

of approximately 500, there are 50 who either have had, have, or will have ulcer during their lifetime. One can sometimes tell by the discussion from the stage who has the ulcers.

There is one thing that I would like to add to your paper, Dr Wilbur, which may explain some of the discrepancy between the clinical symptoms and history and the x-ray findings. The fact is that the clinician is very prone to try an anti-ulcer diet on the patient for two or three weeks before referring him for x-ray examination, and in many such cases, I am sure that an ulcer will heal entirely in that time. This may be the cause of the discrepancy. I think that this practice is to be condemned, and I recommend that the radiologist ask the patient whether or not he has been on an ulcer diet before the x-ray examination.

The question of repeated examinations is also quite important, and I feel that we should reduce the cost of a gastro-intestinal study as much as possible to make these more feasible. However, that is another problem and should not be brought up here.

A third thing is this. Rumor has it that if a patient has chronic duodenal ulcer, he is exempt from the possibility of gastric carcinoma. I would like to put in one strong vote against that opinion, as I have often seen gastric carcinoma in a patient with the scar of an old duodenal ulcer.

Another possible explanation for some of the discrepancy referred to by Dr Wilbur, I believe, is the fact that older patients may have the scar of a previous ulcer which gave them plenty of symptoms when they were young, but, as the gastric acidity dropped with age, those symptoms disappeared. Yet one can still find the scar of the old ulcer. The patient, however, may have no ulcer symptoms at the time.

Joseph C Bell, M D (Chairman) Dr Templeton, will you come forward and defend yourself?

Dr Templeton Thank you, Dr Sosman, for your discussion. Your speaking of the fourth phase brought to mind the fourth dimension. It is pretty hard to define and clarify.

I didn't have time to go into the technique of the gastro-intestinal examination. I shall leave that for my Refresher Course.

There are some key films that one can take when no abnormality is recognized at fluoroscopy. As a rule, these key films help in difficult situations. Take one view as the barium enters the stomach. Take one view of the gastric body after the patient has taken two ounces of barium, and while exerting light pressure. The amount of pressure depends on the thickness of the abdomen. There should be just enough to bring out the folds. Do the same thing with the antrum. In the average stomach, two or three spot views suffice to cover these parts if one uses quarters of 8 X 10's. In the larger stomach, three or four views

are needed After this, take radiographs of the filled-out and compressed duodenal bulb

Dr Sosman raised a question regarding the short, heavy-set patient, in whom the lesion cannot be seen by fluoroscopy because the stomach is located beneath the ribs and cannot be compressed When the abdomen is large, we turn the patient onto his abdomen, and then onto his back cocked toward the left side The bulb is high Air will run into it In a large percentage of the cases one obtains a double contrast view of the bulb In this way I have seen a number of ulcers which would not have been detected with the patient standing

With the patient supine, films of the cardiac end filled with barium are made With the patient turned toward his left side, the beam cuts on across the posterior wall and shows this segment In all, eight exposures are made on two 8×10 films This is the average number of exposures

Now, about antispasmodics I am reminded of the radio quiz-master who quoted one of the participants, only to find that this man didn't recognize what he had written I think, however, that I did not advocate antispasmodics I believe that any favorable effect obtained by their use is more or less psychologic in origin When the patient returns the second time he is more at ease, as he knows what is going to be done I think that this changed mental attitude plays a major role in the success of the examination

Now I am going to ask questions about the small focal spot vs the large spot From a theoretical standpoint Dr Morgan has shown that one can see more with the small than with the large spot Of how much significance is this? Does it really help with fluoroscopy? Is the difference great enough to be of practical significance?

Leo G Rigler, M D (Minneapolis, Minn) There is so much meat for discussion that it is quite difficult to restrain oneself I might say that the fourth stage in gastro intestinal examination, of which Dr Sosman spoke, was reached in Sweden about twenty years ago, where the fluoroscope was used for purposes of localization both as to the chest and the gastro-intestinal tract One difficulty, however, is that you become so intent upon getting the patient in the proper position for the films that you are likely to lose sight of the primary examination, i e, the fluoroscopic examination

We have had rather a long experience in this respect, not with peptic ulcers, but with tumors, in which we have used fluoroscopy alone, fluoroscopy with spot films, and with conventional radiographs made in a variety of positions, and my own feeling at the present time is that I wouldn't want to do without any of the three if I were trying to find small lesions, polyps, for example, 3 or 4 mm in diameter We thought

that we saw them under the fluoroscope, but we were not at all certain of it However, we were able to confirm them by spot films

We know that we have missed carcinomas of 1 cm diameter in the most painstaking fluoroscopic examinations, and we know that we have seen small tumors, measuring say 2 or 2.5 cm in diameter, by fluoroscopy, have demonstrated them by spot films, and then managed to eliminate them completely in conventional radiographs taken with both filled and empty stomach A great part of the data on this question is based on the introduction of foreign bodies, but that is scarcely comparable

I feel very strongly at the present time that, at least for small tumors, we need all three media to arrive at a proper diagnosis

I was somewhat amazed at Dr Wilbur's figures as to the discrepancy between the presence of ulcer, radiographically, and the history, because I don't know of any good data which will support the thesis that a good history means that an ulcer is present As a matter of fact, I think that most autopsy studies indicate that the history is a very vulnerable criterion for the presence or the absence of ulcer I would certainly be reluctant to accept the idea that the history, regardless of how carefully it is gathered and how critically it is appraised, indicates definitely that an ulcer is or is not present, and that, therefore, it would invalidate, to any great degree, the roentgen findings

Ross Golden, M D (New York) The officers of the Society and the essayists are to be greatly complimented Dr Templeton's discussion of the technic of examination of the stomach impresses me as most desirable In George Holmes' Caldwell Lecture in 1940, he expressed regret that the programs of our national societies do not include discussions of the technic of x-ray examinations It would be helpful to all of us if the problem of the technic of gastric examinations could be dealt with as a round-table discussion which would last for an hour or two so that questions could be asked and suggestions could be made

I agree with Dr Sosman that antispasmodics are not worth much When a speaker mentions antispasmodics, he usually means atropine or some form of belladonna, as I understand it If I am correctly informed, atropine can act on parasympathetic nerve endings which are outside of the reactor cell Because the nerve endings are within the smooth muscle cell, there would be little probability that atropine could affect the smooth muscle of the stomach The physiologists believe (I may be wrong about this) that gastric peristalsis is stimulated by the parasympathetic, and that the same stimulus tends to relax the pylorus, whereas sympathetic stimulation tends to cause the pylorus to contract If this is correct,

it is not logical to give atropine, which blocks the parasympathetic, which is supposed to inhibit the sympathetic and, therefore, to relax the pylorus

A number of French radiologists are now using injections of morphine as a stimulant to gastric peristalsis. This method, as far as I know, has been used very little, if at all, in this country and may be worthy of further investigation.

With reference to the remark of Dr Harris concerning the relative importance of fluoroscopy and films, I remember that in 1927 Hans Berg told me that he used fluoroscopy largely as a means for orienting his films. You will remember that Dr Berg played an important part in the early development of the use of spot films. I was a little surprised to hear him make this remark because fluoroscopy meant more to me than a method of centering films.

I find myself in disagreement with Dr Morgan on the size of the fluoroscopic screen. I found that, during gastro-intestinal fluoroscopy, my field never exceeded 10 inches in any direction, but of course I never used a 10 × 10-inch field. Sometimes in studying the transverse or the descending colon, a long, narrow field is indicated. Frequently it is desirable to make an 8 × 10-inch spot film. I would be unhappy with a screen as small as he mentioned. Fluoroscopic inspection of the chest should be part of every gastro-intestinal study. It is desirable to have a screen large enough so that the two sides of the diaphragm can be seen at once.

In regard to protection, we now have available lead rubber aprons which come across the lower part of the neck and out over the shoulders and then down the sides. These new aprons give much better protection than anything we have previously had available.

The paper on gastroscopy was also very interesting. Like Dr Sosman, I would compliment Dr Dailey on his approach. The gastroscope, like the fluoroscope, is merely an instrument which is no better than the man who is using it. I would like to ask Dr Dailey whether he has had occasion at any time to try gastroscopy with the patient in the erect position.

In connection with Dr Wilbur's paper, I would like to point out that any radiologist worth his salt is a clinician. He takes the opportunity during the fluoroscopic examination to ask the patient questions about the character and radiation of pain and other symptoms. The figures presented by Dr Wilbur do not agree with my impressions concerning the value of the clinical diagnosis of ulcer. My impressions have been gained from the examination of patients and from literally thousands of discussions with good clinicians about case problems.

Thank you for this opportunity to make these comments.

Dr Bell If there is no further discussion, I'll give Dr Harris a chance to defend himself.

Dr Harris I think that there is no question that in chest examinations, the detail that is revealed by the film is necessary and that fluoroscopy is of minor importance. However, in gastro-intestinal disease, I believe that there is a group of clinics in this country who have used surgical means to confirm or disprove lesions, both negative and positive, demonstrated by fluoroscopy and have found it very accurate. That is, the fluoroscopic evidence has been very accurate in determining the presence or absence of disease in the stomach and duodenum.

The question comes up, of course, as to the skill of the person using the instrument. I believe that those who can do fluoroscopy well, should use the fluoroscope, those who need spot-film devices, should use them. I don't wish to give the impression that we don't use spot films and don't use routine positions, because we do, but we depend on the fluoroscope, primarily, for the diagnosis.

The duration of the fluoroscopic examination is also important, as Dr Morgan has said. It should not exceed five minutes for the ordinary complicated case and probably only one to two minutes for the uncomplicated case.

As to the question of antispasmodics, we got into that, too. By that I mean the use of antispasmodics in differentiating a spasm of the antrum from an antral carcinoma. However, those cases are rare. I believe that antispasmodics are indicated. Certainly the question of antral spasm resolves itself into something other than relaxing the patient for five, ten, or twenty minutes, or seeing him the next day.

Dr Bell Thank you, Dr Harris. Dr Morgan, do you have anything to say?

Dr Morgan Dr Templeton raised the question of the practical advantage of the small focal spot in fluoroscopy. I should like to say at the outset that the data which you saw on the screen this afternoon were not mathematically calculated data but were derived from physiological experiments, the nature of which we do not have time to go into this afternoon. However, they were based on experiments that closely simulate fluoroscopic conditions, and I believe that the curves that you saw actually represent what you may expect when performing fluoroscopic examinations of the gastro-intestinal tract on average patients. Now, you will notice within those curves that the difference between the small focal spot and the large focal spot is particularly marked in the objects of high contrast, and I think that it is rather significant that the images which you see fluoroscopically of the gastro-intestinal tract are images in which the contrast is

approaching 100 per cent. Although at one time I was a little skeptical about the difference in small and large focal spots, the experimental studies indicate that there is a difference.

You will notice that the size of the object in abdominal fluoroscopy at 100 per cent contrast has to be about twice as large for visualization when the focal spot is very large and the object is about 10 cm. away from the screen than when the focal spot is of the order of 1 mm. Not infrequently that is going to be the difference between picking up a small crater and missing it, and I certainly think that one should avail himself of the best possible apparatus, particularly when present-day equipment makes it easy to obtain fluoroscopic tubes of small focal-spot size just as readily as ones with large focal-spot areas.

Dr Golden raised two questions. One question concerned the size of the screen. We happen to be using an 8 X 10 screen at the present time, although much of our fluoroscopy is done with one of about half that area. I believe that much of the feeling regarding the size of fluoroscopic fields is a matter of personal preference. It is rather interesting to relate one story which I remember from my days at the University of Chicago.

There we had a screen with an area of approximately 28 square inches, but it was possible to hang a regular 12 X 16-in. screen on the fluoroscope with practically no difficulty. It was never a problem of having to unscrew a number of gadgets and go through a lot of other difficult procedures. Well, for the first few days after that fluoroscope went into operation, it was common practice for the fluoroscopists (and that included every member of the group there) to fluoroscope chests with the large screen and then to lift it off and use the smaller screen for other examinations, such as studies of the gastro intestinal tract. It was rather significant, I believe, that within about one or two weeks the large screen was discarded entirely for chest fluoroscopy and has not been used since. That was back in 1938, and the radiologists there have not felt the need of a large screen following their education in the use of the smaller one.

Dr Sosman raised a question about protection in fluoroscopy and the new aprons. As he so admirably brought out, it begins to look as though the danger areas of fluoroscopy can probably be taken care of by lead aprons that can be hung on the screen. Suitable small aprons draped about the screen can probably supplant much of the present heavy paraphernalia, and I hope that our future studies will bear this out. Certainly it would be a great boon to every radiologist if he could do away with the cumbersome apron that he now has to put on, when so much of the scattered radiation that comes out of the fluoroscope is concentrated in such a small area. I hope that by this time next year we can report

some progress in that direction. At least that is the direction in which we shall be working.

Dr Bell Dr Dailey next, please.

Dr Dailey I certainly agree with Dr Sosman's comments that there is no competition between roentgenology and gastroscopy. In fact, the opposite point of view, although sometimes expressed or implied, is quite ridiculous, because the radiologist is the one who has paved the way for the examination of the gastroscopist and, thus, the cards are all stacked in the latter's favor.

In our last 400 patients, we found only 3 ulcers not suspected radiographically, and these were high behind the ribs so that palpation was not possible. As far as the large rugae are concerned, I do agree with Dr Sosman as to their correlation with the acidity of the gastric secretion. In any event, it is obvious that to call such a hyperemic mucosa a gastritis is as inappropriate as to say that a man has a dermatitis when he has a red, sweaty forehead from working in the hay field.

Dr Golden asked if we had examined patients while they were sitting down. Some have done that purely with the idea of trying to visualize the pylorus more satisfactorily. We have done our examinations along the conventional lines.

Dr Wilbur One would anticipate, of course, that a clinician would be taken for a ride by a group of radiologists, but I have a few answers for some of the problems which have been brought up.

Dr Sosman suggested, I believe very wisely, that patients who have symptoms of indigestion should be radiologically examined immediately and not after two or three weeks of treatment. However, I must say that I do not believe that two or three weeks of treatment would make much difference in the results of the examination, because gastric and duodenal ulcers, as a rule, will not heal in that period of time. Recently Cummings, Grossman, and Ivy in studies on the healing time of gastric and duodenal ulcers, as shown by radiological disappearance of the crater, found that the average time of healing of a duodenal ulcer in a group of young men in the Army was approximately forty-two days. Their experience is in agreement with that of other clinicians.

The incidence of carcinoma of the stomach in patients with active duodenal ulcer is a very important problem. I hope that those of you who are working in hospitals with large services will tabulate data on this subject. Some years ago, Dr Rivers and I reviewed this problem and came to the conclusion, although we could not prove it, that carcinoma of the stomach did not commonly occur in patients who had an active duodenal ulcer. The type of mucosa which is present in the stomach of patients with active duodenal ulcer is probably not the type of mucosa which is suitable soil for the development of carcinoma. That

is not a proved fact, however, and I think that additional data are needed

Repeated examinations are extremely important, particularly in those patients whom one sees in private practice, and on whom it is not so easy to obtain frequent repeated examinations or follow up over long periods of time. As far as antispasmodics are concerned, I agree with the majority of the previous speakers. Recently, Dr. Bargen and his associates have shown that, so far as the small bowel and colon are concerned, no antispasmodic, either of the atropine-belladonna series or the synthetic variety, has ordinarily any effect on the musculature of the bowel.

Dr. Golden brought up some interesting problems that I would like to discuss briefly. He mentioned particularly the fact that radiologists commonly ask patients about symptoms, and I've heard a few comments here and there about examinations which last one or two or five minutes. Again, I think that it is a matter of great importance who takes the patient's history. Duodenal ulcer is one of those conditions where, frequently, one can make the diagnosis in the first twenty-five words of history taking. Nevertheless, there are many patients who have a duodenal or gastric ulcer on whom one cannot make the clinical diagnosis on the basis of the history taken in just a few minutes. It is quite true, of course, that there are lesions other than ulcer which will produce the so-called ulcer story: carcinoma of the stomach, gallbladder disease, carcinoma of the pancreas, hookworm disease, etc. However, the clinician will usually find sufficient evidence of these other diseases to put him on guard so far as a diagnosis of ulcer is concerned.

I might also add, since there seems to be some question as to the relative value of fluoroscopy and spot-film examination, that I think the clinician should have his chance to say a word. There is often a disagreement between the clinician and the radiologist following their respective examinations. Under these circumstances, an accurately taken history and repeated radiological examinations are very important. You will recall that my figures showed that in 14 patients for whom x-ray examination was done because of an "ulcer" history, there were only 3 in whom the radiologist reported normal findings. I think that fits in pretty well with what I have just said.

Another important point that all of us are apt to forget is this. When you, as radiologists, make a diagnosis of ulcer, you feel absolutely certain that an ulcer is present, so do I when I take a history of a patient and find a typical ulcer story and nothing else. I feel just as sure as you do that the patient has an ulcer, and yet there is rarely any anatomical evidence that either of us is correct. Even the surgeon, when he operates,

may find slight scarring, but he rarely opens the duodenum, or even when he does, it is sometimes difficult for him to tell whether or not an ulcer is present. Unless one has some definite anatomic evidence for it, I think that we should not accept a radiological diagnosis of evidence of ulcer as absolute. Of course, I am vulnerable in exactly the same way, and you can say that one should not absolutely accept a clinical history as evidence of ulcer either.

The point was raised that 10 per cent of all individuals have duodenal or gastric ulcers some time during their lives, that, of course, is true. It explains the fact that in a number of instances the radiologist finds evidence in the duodenum which leads him to suspect ulcer which the clinician will not accept because he is unable to get a story of ulcer symptoms at any time.

Dr. Bell: There have been at least two hands raised in the front row here, and if there is no objection from the audience, I will give Dr. Golden one minute and Dr. Sosman one minute.

Dr. Golden: For the sake of the record, I would like to comment on Dr. Wilbur's remark concerning the duration of fluoroscopy. When a radiologist says that he fluoroscopes a patient for two minutes he does not mean that the patient was in the fluoroscopic room for only two minutes. He means that the total duration of x-ray exposure was two minutes, or five minutes, as the case might be. The patient might be in the fluoroscopic room for as long as ten or fifteen minutes, but would still get less than five minutes of actual exposure during that time. During a fluoroscopic examination, therefore, one has plenty of time to chat with the patient about his symptoms.

Dr. Sosman: There are two points that I would like to make. One is that, in spite of Dr. Harris' statement, I still think that antispasmodics are no good. In fact, I think they are even worse than that, that it is harmful to give a big dose of an antispasmodic, as one may conclude that, if relaxation doesn't occur under this massive dose of antispasmodic, we must be dealing with a carcinoma. I say that we should throw out antispasmodics, don't use them, don't depend on them at all.

Another thing, Dr. Wilbur, the duodenal ulcers often are shallow lesions, and they may heal in ten days. I have seen that happen again and again. Many of them will heal in three weeks. The healing time of the gastric ulcer depends on its size, and we can make a mathematical chart of the size of the ulcer as related to the time that is required for healing *if the patient is under perfect medical control*, and not in one of the Army hospitals, where he may be very unhappy.

Evaluation of the Effects of Radiation on Non-Malignant Lesions of the Nasopharynx¹

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CROWE (1) CALLED attention to the fact that lymphoid tissue in the nasopharynx, especially the lateral parts, could, as the result of hypertrophy and hyperplasia, cause intermittent or constant blockage of the nasopharyngeal orifices of the eustachian tubes. He noted that such blockage interfered with the normal ventilation of the middle ear cavity and was reflected, most often in children, in decreased hearing. The examination of the ear drums revealed retraction of the tympanic membrane and a reddish blush from the edematous mucosa of the medial wall of the tympanic cavity. Examination with an electric nasopharyngoscope showed actual encroachment of the lymphoid elements on the mouth of the eustachian tube.

It was evident that surgical extirpation of the oral and nasopharyngeal lymphoid structures, no matter how complete, could not reach the laterally placed portions in the fossae of Rosenmüller and about the lips of the tubal orifice without causing serious damage to the mucosa and nearby anatomic parts. Other investigators (2, 3) had previously reported the susceptibility of lymphoid tissue to radiation. Crowe, therefore, with Dr Curtis F Burnam, devised a nasal applicator, the end of which contained a compartment enclosing a specified amount of radioactive material, which could easily be passed along the floor of the nose and be applied directly to the area of the nasopharyngeal orifice of the eustachian tube.

In 1946, Crowe (4) reported on a large series of children with tubal obstruction as shown by decreased acuity of hearing, retraction of the tympanic membranes,

reddish or cyanotic discoloration of the medial wall mucosa, and encroachment of lymphoid tissue on the orifice of the eustachian tube as demonstrated by the electric nasopharyngoscope. After adenoidectomy to remove the large mass of tissue, irradiation by means of the nasal applicator was used. Hearing improved and the other signs of obstruction disappeared. Similar results were not obtained by adenoidectomy alone.

Crowe (4) also demonstrated the relationship of nasopharyngeal lymphoid tissue to allergic manifestations in the nose and bronchi by obtaining alleviation of allergic symptoms by nasopharyngeal radiation, either with or without previous adenoidectomy. Other investigators have corroborated his findings, both in children with hearing loss secondary to tubal obstruction and in those with evidences of allergy.

Fowler (5) extended Crowe's studies to tubal obstruction in adults. During the war, in a carefully controlled series, he was able to demonstrate that many flyers previously incapacitated for duty because of painful aero-otitis and subsequent hearing loss, could be returned to full flying status after application of radium to the tubal orifices. His microscopic slides revealed the destructive effect of radiation on nasopharyngeal lymphoid tissue.

The series of cases to be presented here represents an attempt at a practical evaluation of what may be accomplished by irradiation according to the method advocated by Crowe (1, 6), as modified by him in January 1947. Certain alterations and added indications are necessarily included to meet our particular office requirements.

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CASE GROUPS AND INDICATIONS

This series includes 50 patients who have been followed carefully at the office for a year (March 1947 to March 1948). The cases were divided into four main groups, in the hope of finding the group or groups in which the best results from radiation might be expected.

Group I Thirteen cases of well defined or fixed otologic impairment, either nerve deafness or conductive deafness (the latter otosclerotic or adhesive in character), constituted the first group. Irradiation of the nasopharynx in these cases was used in order to throw light on any possible added detrimental influence that lymphoid tissue about the orifice of the eustachian tubes might have.

In 9 patients (6 children, from three and a half to eleven years, and 3 adults) nerve deafness of a handicapping degree (below 30 decibels) was present. Audiometric tests in this group, before and after irradiation, showed no evidence of improvement in hearing. In the remaining 4 cases, a significant amount of adenoid tissue was present. Two of these patients were young girls, fourteen and seventeen years old, with otosclerosis. Following therapy, one showed a plus 12, plus 6 decibel gain, the other a plus 10, plus 14 decibel gain, but this borderline effect was hardly to be considered of any real value. In the other 2 patients, adults with established adhesive otitis, there was subjective improvement, but audiometrically this could not be demonstrated.

Group II This group comprised our largest number of cases, 25. It consisted largely of children, with only 2 young adults, aged eighteen and twenty-one. The children's ages averaged from four to nine years. An outstanding feature was the tendency to allergy and the frequency of an allergic family background. The most important symptoms were difficult nasal breathing, recurrent earaches, frequent sore throats, hoarseness, secondary nasal infections following colds, mouth breathing, and coughing. Physical findings

included pallor and boggy of the nasal mucosa, reddish blush from the medial wall mucosa, infection of lateral bands of the pharynx, abundant lymphoid follicles on the posterior pharyngeal wall, and, on palpation, lymphoid masses of significant size in the nasopharynx. All had had tonsils and adenoids removed and in all some definite allergic background was present.

Deafness or recurrent episodes of deafness did not seem to be factors in this group. In 23 of the 25 cases, there was considerable improvement of symptoms over a period of two to four months. (We do not anticipate complete alleviation of symptoms.) It is possible that the improvement of nasal and eustachian tube ventilation prevents the occurrence of future hearing loss. We combine radiation therapy with other methods of managing the allergic child in otolaryngologic practice.

Group III The third group comprised 8 patients, 7 adults (ages thirty to fifty) and a child of eight years. Symptoms in these cases were "clicking" noises in the ears, tinnitus of other types, intermittent "stopped up" sensations in the ears—all of which suggested eustachian tube obstruction. As in group II, hearing loss was not a feature. Four of the 8 patients mentioned that some of their symptoms were improved following completion of irradiation. The other patients were unable to report any remarkable change.

Group IV The last group consisted of 3 cases of chronic aural discharge. It was hoped that relief of eustachian tube obstruction would lead to restoration of normal physiology, with resultant diminution in discharge or "dry ear." Following irradiation, however, there was no change in the character or amount of discharge.

COMMENT AND CONCLUSIONS

1. In our hands, irradiation has been useful when combined with other forms of therapy in the child with a syndrome of impaired hearing of transitory character and allergic symptoms, *i e*, difficult nasal

breathing, postnasal drainage, sneezing, coughing, otalgia, and mouth breathing. Associated paranasal infections were invariably present.

2 The effects noted in those cases with fixed impairment of hearing of obvious otologic cause (otosclerosis, adhesive otitis media, nerve deafness) have been disappointing, but not unexpectedly so.

3 In mild disturbances of eustachian tube function, radiation may be of value. More cases and further experience will be necessary to assay its full benefit in these instances.

4 The experiences of Scal (8), Boies (9), Fricke and Brown (10), Harris and Montgomery (11), and Gay (12), have followed a similar pattern.

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SUMARIO

Valuación de los Efectos de la Irradiación en las Lesiones No Malignas de la Nasofaringe

En una serie de 50 casos que comprendían tanto niños como adultos, utilizóse la irradiación de la nasofaringe con el aplicador de radio introducido por Crowe. El procedimiento resultó útil, combinado con otras terapéuticas, en los niños afectados por un síndrome de audición defectuosa pasajera y manifestaciones alérgicas, es decir, dificultad para respirar por la nariz, escurrimiento postnasal, estornudos, tos, otalgia y respiración por la boca. En esos casos hubo invariablemente infecciones paranasales asociadas.

Los enfermos con insuficiencia auditiva

figa de manifiesta etiología ótica (otosclerosis, otitis media adhesiva y sordera debida a afección del nervio auditivo) no se beneficiaron mayor cosa.

En un grupillo de pacientes con trastornos leves, como zumbidos y sensación de "oídos tapados," que indicaban oclusión de la trompa de Eustaquio, el resultado fué dudoso, pero parece que la irradiación puede ser de algún valor en esos casos.

Tres enfermos con otorrea crónica fueron tratados sin resultado.

Las observaciones anteriores convienen con las de otros autores.

Endocrine Factors in Hypertension, Treatment by Roentgen Irradiation of the Pituitary and Adrenal Regions¹

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IN A PAPER PUBLISHED in 1933 it was pointed out by one of the present authors (1) that hypertension and diabetes are similar in so many respects as to suggest a least common denominator among their etiologic factors. Evidence available at that time pointing to endocrine participation in these conditions indicated (a) that the pituitary and adrenals are probably chiefly involved, (b) that an associated hypertension or diabetes, or both, has been found in every variety of hyperpituitarism—gigantism, acromegaly, and basophilism—while hypopituitarism is accompanied by lowered blood pressure and an increased tolerance for glucose, (c) that adrenal tumors are often accompanied by hypertension or diabetes, or both, while Addison's disease is characterized by hypotension and hypoglycemia.

That hyperthyroidism may play a role in some cases of hypertension, which show improvement when the thyroid condition is corrected, has subsequently been suggested (2).

Since 1933, additional evidence has accumulated tending to strengthen the belief that the pituitary and adrenals play some part in hypertension and diabetes. This evidence may be summarized as follows. Diabetes has been produced in the dog by intraperitoneal injections of anterior pituitary extracts (3). In rats, hypertension has been produced by intraperitoneal (4) and intrathecal (5) injections of posterior pituitary extracts, and cardiac hypertrophy and nephrosclerosis have been produced by overdosage of desoxycortico-

sterone acetate and sodium chloride (6). Unilateral adrenal ischemia brought about by subtotal ligation of periadrenal blood vessels causes a prompt and sustained hypertension (7).

MATERIAL FOR PRESENT STUDY

The present study is based on 795 patients with hypertension. 486 of these were seen by one or more of our group, whose names appear above, and 309 were reported to us by other workers. We have seen, also, 42 patients who had both hypertension and diabetes, but these are not included in this report. Some of the patients were employees of the Illinois Central Railroad and had been under observation and treatment by the hospital department for one to fifteen years. The others were encountered in private practice. All were known to have had hypertension for one year or longer and in most the systolic blood pressure was well above 160.

Preliminary studies were intended to be sufficient to establish a diagnosis of essential hypertension. Four patients with nephritis were accepted for treatment, but in only one of these was any improvement noted.

Practically all patients, except those treated by thyroid and pituitary extracts, were within normal limits as to height and weight. The hypercholesterolemia (8) and hypocalcemia (9) reported by others have not been observed in this series. Deviations of the blood sugar were the most significant findings in blood chemistry determinations. Results of glucose tolerance tests in 228 cases were as shown in Table I.

¹ Accepted for publication in April 1948.

None of these patients was considered to have diabetes

TABLE I GLUCOSE TOLERANCE TESTS IN 228 PATIENTS

Blood Sugar Levels	Cases	Cases with Glycosuria
Less than 170 mg %	97	9
170-200 mg %	54	14
Over 200 mg %	77	32
TOTAL	228	55

Results of basal metabolism determinations in 183 cases were as follows

-5 or lower	53 cases
-5 to +10	69 cases
+10 or higher	61 cases

ENDOCRINE ASPECTS OF THE STUDY

In no case has there seemed to be a thymic or parathyroid fault

Gonads The administration of estrogenic preparations in doses sufficient to relieve the menopausal symptoms of women did not materially affect their blood pressure. In 3 patients the hypertension was believed to be associated with the male climacteric. All were given 25 mg of testosterone propionate twice weekly. One case responded favorably.

Thyroid In 6 patients the hypertension was associated with hypothyroidism, but none of these had myxedema. The basal metabolism rate before treatment varied from -10 to -20. The administration of thyroid in adequate doses in these cases was accompanied by a substantial decline

in blood pressure. The dose was kept at that level which would relieve the symptoms without causing tachycardia, heart consciousness, nervousness, or tremor of the outstretched fingers. The basal metabolism rate was not often checked after the preliminary determination.

The following case history is illustrative of the type of response to thyroid therapy in these hypothyroid cases.

A 54-year-old man was first seen on April 18, 1922, complaining of backache and fatigue. He was 30 pounds overweight, the excess being distributed in what was then regarded as a thyroid pattern. The basal metabolism rate was -15, the blood pressure 175/115, weight 184 pounds. Treatment consisted at first of 3 grains of thyroid daily (a Burroughs Wellcome & Co preparation standardized according to the British Pharmacopeia), with a gradual increase in the dose to 2 1/2 grains four times daily. On Sept 1, 1922, the patient's weight was 152 pounds, his blood pressure 125/80, and his pulse 90. On March 7, 1923, the blood pressure was 140/90 and the pulse 72, and the dosage of thyroid was reduced to 2 1/2 grains three times daily.

The patient was next seen on July 9, 1927, when the pulse was 66, blood pressure 220/105, weight 177 pounds. He had taken no thyroid for several years. He was again given thyroid, 2 1/2 grains three times a day. Observations during the next ten years were as shown in the accompanying table.

When the patient returned to the office after a long absence he usually reported that he had discontinued the thyroid several months before his visit. He is said to have died of a stroke in 1945.

Three patients with hyperthyroidism were treated by irradiation of the pituitary and adrenal regions. Their response is illustrated by the following case.

PULSE AND BLOOD PRESSURE DETERMINATIONS IN A HYPOTHYROID PATIENT RECEIVING THYROID THERAPY, AUG 30 1927-MARCH 6 1937

Date	Pulse	Blood Pressure	Weight	Thyroid Dosage
Aug 30 1927	77	155/80	155 1/2 lb	
Jan 17 1928	66	155/80		2 1/2 gr × 4
June 8 1929	66	165/76		2 1/2 gr × 1
Oct 21 1929		140/70		1 gr × 3
Feb 10 1930	75	180/85		1 gr × 3
July 11, 1930	80	120/60		
March 2 1931	64	180/90		1 gr × 3
March 30 1931		140/80		
May 23 1932		165/80		1 gr × 3
June 19 1932	80	150/75		
Nov 17 1933	72	220/100	165 lb	2 1/2 gr × 3
Dec 1 1933	94	175/80		2 1/2 gr × 2
Aug 24 1934	60	165/85	156 lb	2 1/2 gr × 3
June 3 1935	70	155/75		2 gr (U.S.P.) × 1
March 6 1937	66	160/80		2 gr (U.S.P.) × 1

A woman with recurrent hyperthyroidism, who had undergone two subtotal thyroidectomies and was scheduled for a third because of a large mass of thyroid tissue, was taking Lugol's solution when she came under observation. The medication was continued and x-ray therapy was added. After six treatments of 50 to 55 r over each of three areas, the right and left pituitary and both adrenals (120 kv, 2 mm Al filter, 5 ma, 50 cm distance) at weekly intervals, the blood pressure dropped from 205/75 to 135/75 and the basal metabolism rate from +56 to +18. All symptoms were relieved except those due to an already irreparably damaged heart. Seventeen months after the last x-ray treatment the blood pressure was 155/90 and the basal metabolism rate +14. The mass of thyroid tissue was apparently unchanged.

McGregor (10) reported satisfactory results in his efforts to prevent postoperative hyperthyroid crises by preoperative irradiation of the pituitary and adrenal regions, using the same technic which we employed in the treatment of hypertension.

In this connection it should be pointed out that the role of the thyroid in hypothyroidism is well understood and that in its severe form, as myxedema, hypothyroidism may produce a picture resembling nephritis, on the other hand, our understanding of the exact role of the thyroid in hyperthyroidism is still incomplete.

Adrenals Adrenal biopsies were done in two female patients and no adenomata were found. Small ones were found in a third patient postmortem, too small to have been recognized except on surgical exploration. The history of this patient follows.

The patient was first seen on Sept. 9, 1934, when she was 34 years of age. She complained of irritability, shortness of breath, and precordial distress. Her temperature was 99.6°, pulse 100, blood pressure 260/145. She had known that she had hypertension for four years. Her eyes were prominent, suggesting exophthalmos, and the conjunctivae were injected. There was an excessive amount of hair over the body and face. The basal metabolism rate was -5.

Irradiation was given to the pituitary and adrenals. Between Sept 17 and Dec 7, 1934, the pituitary region received 1,400 r and the adrenal region 777 r, measured in air. Symptoms were relieved, and the blood pressure decreased to 220/145 right and 195/135 left.

The patient was next seen on Dec. 31, 1935, when

her blood pressure was 250/160 and basal metabolism determinations, reported from another hospital were +55 and +35. She complained of headache, palpitation, and dyspnea, and was disoriented at times. X-ray treatment produced a drop of 20 mm in blood pressure, lasting about twenty-four hours. Death occurred Jan 15, 1936, of myocardial failure. Post-mortem examination showed hypertrophy of the heart, nephritis, hyperplasia of the hypophysis and thyroid, and adenomata in both adrenals.

Another case was followed from 1936 to 1948.

A 60-year-old widow came under observation on Feb 26, 1936. She had known that she had hypertension, she said, for seven years. She also had a glaucoma and in earlier years had a bleeding duodenal ulcer, which continued to flare up occasionally. Her first blood pressure reading was 220/130. She was given x-ray treatment two to six times a year, with the same technic and dosage already described—50 r to each of three areas (two pituitary and one adrenal). The first three blood pressure readings were as follows:

Feb 28, 1936	175/110
March 7, 1936	160/110
April 4, 1936	155/90

The blood pressure readings at approximately one-year intervals, together with the dates of the x-ray treatments in each of these years are shown in the accompanying table. The blood pressure was sometimes higher and sometimes lower than on the dates recorded.

Date	Blood Pressure	X-ray Treatment (three areas), 50 r each
Feb 3 1937		X-ray treatment
April 9 1937	160/90	
June 2 1937		X-ray treatment
Feb 14, 1938		X ray treatment
Feb 21, 1938		X-ray treatment
April 9, 1938	160/95	
June 26, 1938		X-ray treatment
Sept 14, 1938		X ray treatment
Feb 10, 1939		X-ray treatment
April 12 1939	160/95	
Sept 9, 1939		X-ray treatment
Sept 22 1939		X-ray treatment
Oct 14 1939		X ray treatment
Nov 10 1939		X-ray treatment
Jan 12, 1940		X-ray treatment
April 17, 1940	160/95	
Aug 10, 1940		X-ray treatment
Aug 19, 1940		X-ray treatment
Nov 30, 1940		X-ray treatment
Dec 31, 1940		X-ray treatment
Jan 27, 1941		X-ray treatment
Feb 5 1941		X-ray treatment
March 31, 1941		X-ray treatment
April 19, 1941	180/105	
April 21, 1941		X ray treatment
May 10 1941		X-ray treatment
Sept 29, 1941		X-ray treatment
Jan 19, 1942		X-ray treatment
April 20, 1942	165/110	

May 18 1942		X-ray treatment
Aug 25, 1942		X-ray treatment
Oct 3, 1942		X-ray treatment
Nov 6 1942		X-ray treatment
Dec. 21 1942		X-ray treatment
Feb 27 1943		X ray treatment
April 19 1943	160/110	
July 8 1943		X-ray treatment
Aug 26, 1943		X-ray treatment
Oct 7, 1943		X-ray treatment
Jan 19, 1944		X ray treatment
Feb 24, 1944		X-ray treatment
April 17, 1944	165/95	
May 11, 1944		X-ray treatment
Nov 11, 1944		X ray treatment
Nov 24 1944		X-ray treatment
April 14, 1945		X ray treatment
April 15 1945	165/100	
Nov 1 1945		X-ray treatment
Jan 19 1946		X-ray treatment
April 30, 1946	170/105	
Aug 30 1946		X-ray treatment
April 11 1947	180/90	
May 15 1947		X-ray treatment
Nov 5 1947		X-ray treatment
April 7, 1948	170/100	

Fifteen patients (2 men and 13 women) were obese, middle-aged, and thought to have pituitary-thyroid deficiency. All but one were put on a diet of 1,200 calories (carbohydrate 80, protein 80, fat 40 gm). All were given thyroid in tolerance doses (2 grains per day was the usual dose), and all received injections twice weekly of 0.5 cc of anterior pituitary extract² and 0.5 cc of posterior lobe extract, representing 5 units. These were given in the same syringe at the same time. One man and 10 women showed significant improvement. The history of the first of this group is as follows:

An Illinois Central locomotive engineer, aged 62 years, was admitted to the hospital because of dyspnea, swelling of the feet for three years, and pain and swelling of the abdomen for one year. He complained also of vertigo and headache for the past few months, and of marked diurnal somnolence. He weighed 222 pounds. Heart tones were distant, and a systolic murmur was heard over the aortic area. There was pitting edema to the knees. The liver was tender and a ventral hernia was present. Blood pressure was 186/90. There was a trace of albumin in the urine. Blood uric acid was 5.5 mg per cent, cholesterol 195 mg per cent, the basal metabolism rate -9.

The patient's trouble was considered to be due to cardiac insufficiency and he was treated by bed rest, low calorie diet, and digitalis, without effect. Because of the obesity, dry skin, brittle nails, and other

signs of thyroid and pituitary deficiency, an endocrine component was suspected. In spite of the hypertension, the patient was given 5 units of a posterior pituitary extract and his blood pressure checked thereafter at fifteen-minute intervals for one hour. It dropped from 184/84 to 144/60. The following day an injection of 0.5 cc. anterior pituitary extract had a similar effect. Both extracts were then given twice weekly, with 1 grain of thyroid per day. On that regime the blood pressure dropped to 125/80, and the edema and other symptoms disappeared, and there was a loss of 35 pounds in weight. The patient was still in good health at the time of his retirement from service some years later.

Only obese patients who show signs of thyroid and pituitary deficiency are considered as candidates for this treatment, and their reaction to these extracts is tested out before any treatment is given. That is, the patients are given one extract on one day and the other on another, and their blood pressure response is checked at fifteen-minute intervals for an hour or more. Unless the blood pressure shows a marked drop, no further injections are given.

We realize that the treatment of these 15 patients seems to be in conflict with statements made in the opening paragraphs, and we offer no explanation of the mechanism. Griffith *et al* (11) recently reported on the use of pitressin in hypertension and suggested that injections of this preparation led to the formation of antihormones which reduced the output of pituitary hormones. We do not feel that this was true in the cases here reported, because the fall in blood pressure occurred so promptly after the injection.

Seven patients (5 women and 2 men) were thought to show evidence of anterior lobe deficiency, the most obvious features being short stature, delicate osseous development, and a basal metabolism rate below normal. All were given small doses of thyroid daily and 0.5 cc of anterior pituitary extract twice weekly. Five (4 women and 1 man) showed significant improvement of symptoms and fall in blood pressure. The following case history indicates the type of case and its response.

² Anterior Pituitary Extract (Parke Davis & Co) formerly marketed as Antuitrin.

A 48-year-old man reported that he had been found to have hypertension three years before. It had produced no symptoms. He was 5 feet 7 1/2 inches in height and weighed 179 pounds, and his face was suggestive of acromegaly. Roentgenograms of the sella showed the longest diameter to be 13 mm, but there was no sign of erosion of the clinoid processes or sellar floor. The blood pressure was 155/100. Physical examination was otherwise negative. The basal metabolism rate was -16. An injection of 0.5 c.c. of anterior pituitary extract was followed by a fall in blood pressure to 130/95. The injections were continued once a week, plus 1/2 grain of thyroid per day. The blood pressure fell to 120/80.

In this group of cases, also, we are at a loss to explain the mechanism of the fall in blood pressure. All patients showing evidence of growth hormone deficiency are tested for their response to anterior pituitary extract. If a pronounced fall in blood pressure occurs within an hour after the injection of 0.5 c.c., it is considered likely that the patient will be benefited by a course of such injections given twice weekly. Obviously, such cases are not common, as we have encountered only 7 such patients in a series of 486.

Of the 12 physicians in our series, 3 were treated surgically as well as by x-ray. One was under irregular observation and treatment for about one year, during which he was symptomatically improved and his blood pressure was maintained at about 180/120. It rose, soon after treatment was discontinued, to its pretreatment level of 240/140 and bilateral splanchnicectomy was done. Immediately after the operation, the symptoms practically disappeared and the blood pressure fell to nearly normal figures. This lasted about four months, when symptoms recurred, the blood pressure again rose to approximately its preoperative level, and death ensued shortly thereafter from cerebral hemorrhage.

The second physician experienced some symptomatic relief and his blood pressure fell almost to normal. After about six months, however, symptoms returned and the blood pressure rose to approximately its preoperative level. Irradiation had no effect on either symptoms or blood pressure. Death ensued from renal insufficiency.

In the third case symptomatic relief lasted about three years. The patient did not know when his hypertension recurred. One x-ray treatment relieved the symptoms but had little effect on the blood pressure.

Two other patients have undergone surgical as well as x-ray treatment. The history of one of these follows.

Mr. T. was admitted to the hospital in 1929 at the age of 27 because of recurrent glomerulonephritis which had attacked him first in 1919. About the middle of 1932 he was seen in the Out-Patient Department for hypertension. His blood pressure was then 170/110. In February 1934 it was 165/110. After four x-ray treatments, it dropped to 145/105, and the patient was symptomatically improved. In February 1937, he was admitted to the hospital because of headache, vertigo, and failing vision due to retinal hemorrhages and papillary edema. His blood pressure was 240/180 and a renal function test showed the phenolsulfonphthalein output to be only 40 per cent. In May 1937 he underwent bilateral splanchnicectomy, and the systolic blood pressure is said to have dropped from 260 to 180 (the diastolic was not reported). He was practically symptom-free until September 1942, when he again complained of failing vision and the blood pressure had risen to 205/140. He was admitted to the hospital for hemorrhages in the eye associated with hypertension, and while there contracted pneumonia, following recovery from which he was discharged for a long rest.

In May 1943, headache recurred and the blood pressure was 210/130. The patient's chief complaint, however, was bilateral gynecomastia, which became quiescent after a course of injections of chorionic gonadotropin and testosterone propionate. The blood pressure response to that treatment, which was not given by us, is not recorded.

The patient was again seen in June 1944, because of headache and vertigo. The blood pressure was 190/130. It dropped, after x-ray treatment, to 155/105 and symptoms improved. The blood pressure was maintained at about 160/100 by further x-ray treatments on June 19 and 26, Aug. 2, and Oct. 27, 1944, but had risen to 190/130 in February 1946. X-ray treatment was again given, and the blood pressure again dropped to 160/110, at which figure it has been maintained by repeated irradiation (Feb. 11 and 25, March 11, and Aug. 19 and 26, 1946). The patient remains almost free of symptoms.

RATIONALE OF X-RAY TREATMENT

Since 1914 unsuccessful attempts have been made to reduce the blood pressure of hypertensive patients by irradiation of the

adrenals Raab (12) reported relief of angina pectoris by this means, though the blood pressure was not significantly affected. Irradiation of the pituitary is said to have caused considerable improvement in selected cases of hypertension (13, 14). So far as we know, however, we were the first to attempt to combine irradiation of the pituitary and adrenal regions with small doses of x-ray in the treatment of this condition.

A number of theories may be advanced to explain the phenomena noted in this report. It is possible that small doses of x-ray have a regulatory effect on pituitary function, changing the proportion of the various hormones elaborated. The same dose, for instance, is effective in various menstrual disorders. A similar regulatory effect may be true of the adrenals. If the kidney elaborates a pressor or antipressor substance, one might be increased or the other decreased by the rays.

Since the effects seen following irradiation of the pituitary and adrenal regions are so similar to those reported as following sympathectomy, it may be that the effects of irradiation are mediated through the sympathetic system.

TECHNIC AND RESULTS OF TREATMENT OF HYPERTENSION BY X-RAYS

Four hundred and thirteen patients with essential hypertension were treated by small doses of x-rays to the regions of the pituitary and adrenals.

Dosage, Technic, and Precautions. As this was a new venture and we wished to be on the safe side, we began with very small doses of radiation. The first case was followed for one year before a second was accepted for treatment. Later we gradually increased the dose, but found that when more than 100 r was applied to each area, worthwhile results were not obtained.

The factors we have found most satisfactory are 120 kv, 3 mm aluminum filter, 50 cm skin-target distance, 3-5 ma. About 50 r, measured in air, are delivered to each area treated. Irradiation

is applied to three areas at each sitting—to both sides of the pituitary through a 10×10 cm portal and to the adrenals through a common portal 15×15 cm.

We do not know that this is the ideal dose, nor do we know whether the dose should be varied from one patient to another or in the same patient at different times. Our experience with heavier doses has already been mentioned. Other workers using higher dosage have reported them as without satisfactory effects (15).

We cannot explain why small doses should produce good results when larger ones fail. This, however, is not an unusual observation. Others have discussed these phenomena (16). Small doses of x-rays are beneficial in the treatment of certain infections, where larger doses are ineffective. The same thing is observed in the action of some drugs (20).

The blood pressure should be checked at intervals of three to seven days, particularly after the first treatment. *If symptomatic relief and a marked fall in blood pressure occur, no further treatment should be given until the blood pressure rises or symptoms recur.* One or two treatments are thus sufficient in some cases for several months. If no such favorable reaction occurs after the first treatment, another is given about one week later and treatments are then given at weekly intervals until a total of six have been given, provided a favorable response does not occur sooner. *Whenever a marked fall in blood pressure or relief of symptoms occurs—whether it be after the first or some subsequent treatment—treatment is discontinued until there is a rise in blood pressure or a recurrence of symptoms.*

Presumably a greater number than six of these treatments could be given in one series, but in order to be conservative we have arbitrarily limited the number to six. After an interval of six weeks, another series of treatments may be given if needed.

Results. The results of treatment are shown in Table II. A patient was considered improved when there was a fall

of at least 30 mm systolic and 10 mm diastolic pressure, along with symptomatic relief

TABLE II RESULTS OF TREATMENT

Adequately treated (3 or more treatments)	
Improved	231 (70 4%)
Unimproved	97 (29 6%)
Total	328
Inadequately treated	60
Not followed	25
Total	85
Cases reported by others	
Improved	238 (77 0%)
Unimproved	71 (23 0%)
Total	309
Grand total	722

As appears from this tabulation, 413 patients received small doses of roentgen rays, according to the technic outlined above, with relief of symptoms and a fall in systolic blood pressure of 30 mm or more in 70 per cent of those adequately treated. When further treatment was needed, heavier doses were applied. These doses were without beneficial effect on symptoms or blood pressure. After waiting six weeks, treatment was again resumed with small doses, and again the same beneficial result as originally noted was seen.

Three patients who responded favorably to small doses, when further therapy was needed were given a placebo treatment, which was without effect. The use of the small doses of radiation at a later date again proved effective.

Two roentgenologists, in cities twenty-five miles apart, used this method of treatment. One used the small doses we employed and reported that his results duplicated our own. The other used larger doses and reported no effect on blood pressure or symptoms.

In many instances in our series the blood pressure dropped shortly after the first treatment. In some the systolic pressure was lowered 40 to 60 points, while the diastolic remained unchanged. In others the diastolic showed the greater reduction.

Symptomatic relief is usually more striking than the drop in blood pressure and often occurs when the blood pressure is scarcely affected. Furthermore, many patients who experience a fall in blood

pressure and symptomatic relief do not have a recurrence of symptoms when the blood pressure returns to pretreatment levels. The symptoms most often and most promptly relieved are headache, vertigo, nervous tension, irritability, heart consciousness, precordial distress, and insomnia. Headache and vertigo often disappear while the patient is receiving the first treatment.

An example of relief from precordial distress is furnished by the case of a thirty-seven-year-old woman who had known of her hypertension for one year and experienced frequent attacks of substernal distress. From April to October 1944 she took 650 glyceryl trinitrate tablets to relieve these attacks. An x-ray treatment was given Nov 1, 1944 and from then to May 10, 1945 she required only three tablets.

Duration of Effects Relief of symptoms and reduction in blood pressure last for variable periods of time in different patients and even in the same patient at different times. Some respond favorably for only a short time. These patients complained of headache following the first treatment. In those cases no further x-ray treatment was given. In a large percentage of the patients, by checking symptoms and blood pressure weekly and repeating the treatment as needed, symptoms can be controlled and the blood pressure maintained at substantially lower levels over a period of years. Eventually patients seem to become resistant to treatment. After a period of years—six to eight in our experience—the blood pressure rises even in those who originally responded favorably, and is uninfluenced by further x-ray irradiation, while the symptoms are less strikingly relieved.

We do not know that this treatment prolongs life, though it does in many cases prolong the working ability of these sufferers and makes them much more comfortable.

Comment Other structures about the pituitary and adrenals are, of course, exposed to the same rays, and changes

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Results. The results of treatment are shown in Table II. A patient was considered improved when there was a fall

sure As many as six treatments may be given in a series, at weekly intervals, and the series may be repeated as needed Eventually, however, the treatment ceases to be effective (after six to eight years in the authors' experience)

No evidence of x-ray damage has ever been observed following this treatment, and in two cases postmortem study has revealed no injury to the pituitary, adrenals, or other tissues or organs

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SUMARIO

Los Factores Endocrinos en la Hipertensión Tratamiento con los Rayos X de las Regiones Hipofisaria y Adrenal

Parece que por lo menos una pequeña proporción de los casos de hipertensión se asientan en un fondo endocrino y que todo enfermo que padezca de dicho trastorno debería disfrutar del beneficio de un estudio endocrinológico Una serie de 795 casos acumulados desde 1932 ha sido estudiada desde ese punto de vista, y aquí se comunican los beneficiados con varias formas de endocrinoterapia

La pituitaria y las adrenales parecen ser las afectadas más a menudo y los rayos X

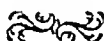
han sido asestados a esas regiones con mira a cohibir los síntomas y rebajar la tensión sanguínea Los AA mismos han tratado 413 enfermos, con mejoría (baja de la tensión sanguínea por lo menos de 30 mm en la sistólica y 10 mm en la diastólica, con alivio sintomático) en 70 por ciento de los que recibieron tratamiento adecuado

Los factores que resultaron más satisfactorios fueron 120 kv, 3 a 5 ma, filtración por 3.0 mm de Al y distancia foco-piel de 50 cm La irradiación se aplica a tres zonas

en cada sesión dos puertas, cada una de 10×10 cm, en la hipófisis, y una de 15×15 cm sobre las adrenales, cada puerta recibe unos 50 r, medidos al aire. La presión sanguínea es determinada repetidamente después del tratamiento, y sólo se repite la irradiación si no hay respuesta favorable al primer tratamiento o si hay recurrencia de síntomas o alza de la tensión. Pueden administrarse en una serie hasta seis trata-

mientos a plazos semanales, repitiéndose la serie según se necesite. Sin embargo, con el tiempo el tratamiento deja de ser eficaz (al cabo de seis a ocho años en la casuística de los AA.)

No se han observado jamás signos de lesión roentgenológica a continuación del tratamiento, y en dos casos la autopsia no reveló lesión de la pituitaria, adrenales o de otros tejidos u órganos.



A Rapid Quantitative Scale Method for Estimating the Percentage Concentration of Priodax in the Gallbladder¹

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EVALUATION OF THE concentration of Priodax (brand of iodoalphonic acid) in the gallbladder during cholecystography has, up to the present time, been subject to variations incidental to different roentgen technics and the personal equation of the interpreter, all other conditions remaining equal. This paper reports a method which automatically eliminates these two variables and equalizes the results of Priodax cholecystography irrespective of technical factors and personal variations.

This is accomplished by use of a stepped scale² previously standardized against varying percentage concentrations of Priodax, beginning with the highest concentration possible and ending with the smallest concentration visible to the eye. In other words; the use of a simple, direct-reading five-step scale of known density variations, with which the opacified gallbladder image can be compared directly on the film. The thickness of the matching step obviously increases with the increase of dye concentration.

Radiography is a study of contrasts in density. Since, ordinarily, the normal gallbladder cannot be differentiated from its surrounding tissues, a method for enhancing its contrast had to be devised. This was originally done by Graham and Cole (1) in 1924, with the aid of tetrabromphenolphthalein, which they injected intravenously. This procedure embodied an entirely new and original radiological principle, *i.e.*, utilization of the specific functions of a system to engender a difference in density. Cholecystography is, therefore, largely a test of physiological capacity.

Small variations in the opacified gallbladder as to size, shape, position, and capacity are unimportant if the organ is well visualized, shows a progressively intense opacification, is capable of altering in size, and empties after the administration of a fat-containing meal.

Priodax is beta(4-hydroxy-3,5-diiodophenyl)-alpha-phenylpropionic acid. At the present time it is the product of choice for cholecystography, since it possesses the following advantages. Attendant nausea, griping, and diarrhea, when present, are usually mild. Vomiting is uncommon. There is less patient resistance, the medium is readily accepted and is simple to administer. It is readily absorbed from the gastro-intestinal tract, affording freedom from confusing opacification of the colon due to non-absorbed dye. The number of repeat or confirmatory examinations is minimized. The use of other drugs, such as paregoric, is eliminated. The dye is administered orally, in tablet form, usually in a set of six tablets, each containing 0.5 gm. of the dye, given five minutes apart, with water, the evening before the examination.

The dye is picked up from the blood by the liver and excreted into the bile. In an effort to approximate the percentage concentration of Priodax in the bile, we examined the latter at suitable intervals after the oral administration of the dye to patients whose gallbladders had been removed and in whom there were drainage tubes in the common ducts. We found an average concentration of about 0.2 per cent. It is important to emphasize that this figure is only a very doubtful approxima-

¹ This study was aided in part by a grant from the Schering Corporation, Bloomfield, N. J., manufacturers of Priodax (brand of iodoalphonic acid). Accepted for publication in August 1948.

² Acknowledgment is made to Mr. Oscar S. Swarth of the Schering Corporation, who diligently collaborated in the development of the scale.

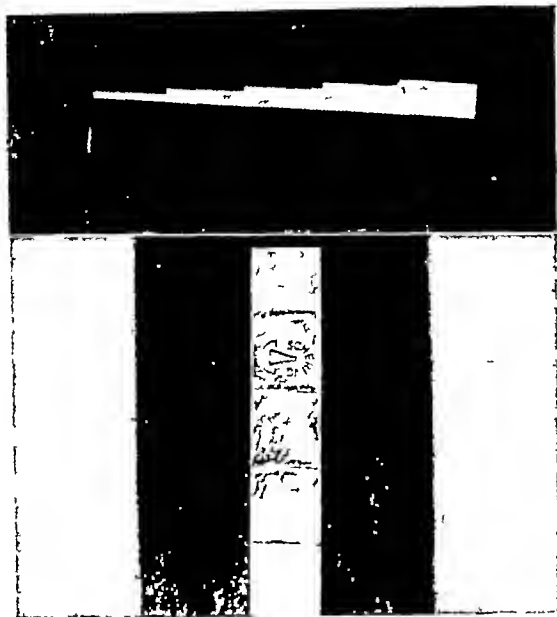


Fig 1 Photographs of the scale

tion, since the circumstances under which the tests were made were abnormal, and the exact percentage was very difficult to obtain.

The bile is conveyed in small amounts by the various-sized hepatic ducts into the main hepatic duct. The regulatory mechanism at the duodenal end of the common bile duct, consisting of the tonicity of the duodenal wall and the action of the sphincter of Oddi, during the fasting period, controls and diverts the passage of bile from the hepatic duct, through the cystic duct, into the gallbladder, where the dye is concentrated by loss of water and other substances through absorption and by the addition of mucin derived from the gallbladder mucosa. This absorptive power or concentration ability is one of the very important factors in visualizing the normal gallbladder after the administration of dye and in determining the density or the degree of opacification.

At the beginning, the possible range of concentration of the dye in gallbladders was unknown to us. We proceeded without any data from the literature. By trial and error we actually found that the dye is concentrated up to 4 or 5 per cent in the gallbladder. This was determined by com-

paring the density of the opacified gallbladder during cholecystography with the density of the standardized stepped scale, described more fully below. The first finished scale had only four steps (1 to 4 per cent), and although the few extreme densities actually encountered most nearly matched the 4 per cent step, there was occasionally a question as to whether the concentration was not somewhat greater. We considered and finally added the fifth step, or 5 per cent, first as a contrasting step to help us to decide on step 4 as against step 5 and, second, on the possibility that such a concentration might occur normally or pathologically (debatable), as in papillomatous disease of the gallbladder. (2) The findings, therefore, suggest a concentration of 20 to 25 times. This concentration, however, may not actually be so large, owing to the doubtful character of the 0.2 per cent concentration of the dye in the bile coming from the liver.

The scale, as pictured (Fig 1), consists of five steps made from aluminum bar stock. Step one, the thinnest, and therefore the most radiolucent, is 44/1,000 of an inch in thickness. The second step is a multiple of two, and so on, until the fifth or thickest step, which is 220/1,000 of an inch or five times the thickness of step one. These five steps were determined and standardized experimentally by utilizing human and artificial gallbladders with walls of radiodensity equivalent to the normal. These organs were filled to a capacity of 40 c.c. and measured 7.5 to 9 cm. in length and 3 cm. in their greatest breadth. They were filled with different concentrations of Priodax and roentgenograms were obtained simultaneously on the same film with varying scale thicknesses, until a visual match was secured. The following equivalents were obtained (for a 40-c.c. capacity gallbladder):

- Step 1, 44/1,000 in. thick, to 1% concentration
- Step 2, 88/1,000 in. thick, to 2% concentration
- Step 3, 132/1,000 in. thick, to 3% concentration
- Step 4, 176/1,000 in. thick, to 4% concentration
- Step 5, 220/1,000 in. thick, to 5% concentration

Since there is a definite cycle for the

behavior of each individual cholecystographic medium, the periods for radiographic examination are predetermined. The interval after the oral administration of Priodax is usually sixteen hours.

The roentgen technic is very simple. After the patient is positioned and before the exposure is made, the scale is placed between the patient and the x-ray table laterally on the right side between the iliac crest and the last ribs, as indicated in Figure 2. The film is exposed and processed in the usual way. Thus the scale is subjected to the same possible technical variations as is the opacified gallbladder. The procedure is rapid and does not interfere with the diagnostic value of the film.

If the size of the gallbladder is within the usual normal range, the density is matched against one of the steps and the concentration read off directly from the step numbers. A slight variation in size will not significantly alter this reading. If, however, the size is abnormal, the concentration is easily obtained by dividing the matching step number by the relative size of the visualized gallbladder. For example, if the gallbladder matches step 2 in density and is twice the normal expected size, the concentration, obtained by dividing 2 by 2, is 1 per cent. If the gallbladder matches step 2 and is one-half the normal expected size, the concentration is obtained by dividing 2 by 1/2, namely 4 per cent.



Fig 2 Roentgenogram illustrating use of scale

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SUMARIO

Técnica Rápida de Escala Cuantitativa para Calcular la Concentración Porcentual de Priodax en la Vesícula Biliar durante la Colecistografía

Para medir la concentración de Priodax en la vesícula biliar durante la colecistografía los AA emplean una escala de aluminio, que comprende cinco grados de espesor cada vez mayor, de 110/1000 a 550/1000 de 1 cm. Los cinco grados representan concentraciones de 1 a 5 por ciento. En la práctica, se coloca la escala entre el enfermo y la mesa de rayos X de costado sobre el lado derecho entre la cresta ilíaca y las últimas costillas, exponiéndose después

la película y trabajándose en la forma habitual. Si el tamaño de la vesícula biliar es normal o casi normal, puede determinarse el espesor directamente por la escala. Si el tamaño es anormal, se obtiene la concentración dividiendo el número del grado correspondiente por el tamaño relativo de la vesícula. Por ejemplo, si la vesícula alcanza el doble del tamaño normal y empareja el grado 2 en espesor, la concentración porcentual es 2/2, ó 1 por ciento.

The Sensitometry of Roentgenographic Films and Screens¹

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DURING THE PAST year, the Tuberculosis Control Division of the United States Public Health Service has established within its roentgenological facilities at Rockville, Maryland, a sensitometry laboratory for the testing of roentgenographic films, screens, and developing materials. The primary purpose of this laboratory is the procurement of reliable speed data on these products for the guidance of the Division in choosing the most satisfactory roentgenographic materials for its use. It is planned, however, to publish many of the data obtained from time to time and it is hoped, therefore, that this new facility will prove useful, also, to roentgenologists in general.

Although quantitative data giving the speeds of commercial roentgenographic films, intensifying screens, and developers will be of rather limited benefit at first, it is anticipated that the availability of such information will constantly stimulate the roentgen industry to improve the quality of its products. Also, it is expected that the experimental investigations conducted by the laboratory in the performance of its testing will yield much information which will be useful to roentgenologists in the improvement of their technical procedures. Furthermore, when automatic photoelectric timers become more widely used the film-screen data will greatly facilitate the use of these instruments by making it possible to complete their adjustment simply by turning their sensitivity controls to the speed numbers of the films or film-screen combinations which are being used.

The institution of a program of roentgenographic sensitometry has required that a standard definition of film, screen, and

developer speed be established and that methods of film, screen, and developer speed measurements be developed which comply with the definition. In the following paragraphs, the standard speed definition which has been adopted by our laboratory will be discussed in detail. Thereafter attention will be directed to a description of the equipment with which roentgenographic sensitometry is performed in compliance with this definition.

STANDARD DEFINITION OF ROENTGENOGRAPHIC FILM, SCREEN, AND DEVELOPER SPEED

Basic Considerations In photographic practice, film speed is customarily defined as the reciprocal of the exposure required to produce a particular photographic effect,⁴ that is,

$$S = \frac{k}{E} \quad (1)$$

where S is the film speed, E is the exposure required to produce a particular photographic effect, and k is a constant of such magnitude that the values of S fall within a convenient range of numbers.

There can be little question that this definition is basically sound, since it assigns speed numbers to films in inverse proportion to the quantity of radiation required to affect them, that is, films which are darkened by a small amount of light will have higher speed ratings than those which require large amounts of radiant energy. Unfortunately, the particular photographic effect referred to in this definition has never been standardized by the photographic industry and, accordingly, a film may have a number of speed

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⁴ For a complete discussion of the definition and measurement of photographic film speeds the reader is referred to Mees (1).

ratings depending on the number of laboratories that have tested and published quantitative data upon it. In this country, the ratings determined by the laboratories of the Weston and General Electric Companies are among the most widely used.

At the present time, the particular photographic effect referred to in the speed definition is usually specified in either of two general ways. In one, a definite photographic density is indicated, for example, in the German DIN system (2, 3), the speed of a film is evaluated from the exposure required to produce a density of 0.1 above fog. Since photographic densities can be measured precisely, speed ratings derived from such a specification should be generally reliable. The density of a film is markedly affected, however, by the developing conditions employed in processing the film unless a developing time considerably in excess of normal is used. Accordingly, developing conditions must be meticulously controlled when this specification is employed.

The other specification of photographic effect is more complex and requires determination of the inertia exposure of the film under test. This exposure is derived by giving the film a series of graded exposures and plotting the resulting photographic densities against the logarithm of the exposure. A curve similar to that shown in Figure 1 will be produced. The linear portion of the curve is then extended downward until it crosses the log exposure axis. The point of crossing is the inertia exposure and is the value used in equation (1) to determine the film's speed. This specification has the advantage that in some films the inertia exposure is relatively unaffected by developing conditions and it is not necessary, therefore, to control development as precisely as when the density specification is used. However, the inertia exposures of many of the more highly sensitive films of recent years exhibit considerable instability with changes in development and the advantage of the specification is therefore questionable.

The speed of a roentgenographic film,

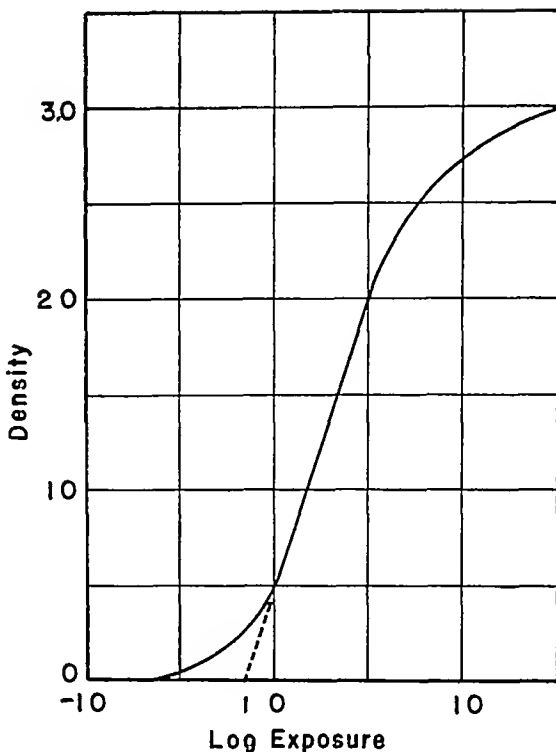


Fig. 1 Relationship between the logarithm of the exposure received by a typical photographic film and the resultant density of the film.

like that of a photographic material, may be defined as the reciprocal of the exposure required to produce a particular roentgenographic effect. Such a definition immediately raises the question as to how the term, *particular roentgenographic effect*, should be specified. For a number of reasons, we favor a density specification. First, the density of a roentgenographic film is one of the most important factors controlling its interpretability (4). Such a specification, therefore, should yield roentgenographic speed numbers of practical significance to the roentgenologist. Furthermore, roentgenographic films customarily are developed to a point where the density is influenced only moderately by developing conditions, and it is anticipated that with wider use of automatic timing methods, long development times, in which density is essentially unaffected by developing conditions, will be generally employed. Finally, the linear portions of the density-log exposure curves of roent-

genographic films are extremely short, thereby making the evaluation of their inertia exposures very difficult. It therefore seems that a density specification has much to recommend it. There remains only to decide what density shall be stipulated.

It has been previously suggested by one of us (4) that this density be of the order of 1.0. Such a density is midway in the useful range of film blackening and accordingly represents the average density of the significant portions of a correctly exposed roentgenogram. *It therefore seems reasonable to propose that the speed of a roentgenographic film be defined as the reciprocal of the exposure required to produce a film density of 1.0 above fog density and the density of the film base.*

The foregoing definition of roentgenographic film speed applies equally well whether a film is exposed with or without intensifying screens. The speed ratings of films exposed with screens will, of course, be considerably greater than those exposed to roentgen rays directly. Furthermore, the speed ratings of films exposed with screens will depend on the brand of screen employed. In view of the latter fact, roentgenographic films may have a number of speed ratings depending on the number of brands of intensifying screen that are available. To avoid confusion when speaking of the speed numbers of films exposed with screens, it is recommended that one refer to such numbers as representing the speeds of film-screen combinations rather than of films alone.

It has been suggested by a number of workers that separate sets of speed numbers be assigned to roentgenographic films and intensifying screens, the speed rating of any given film-screen combination could then be obtained merely by multiplying the speed of the film by the speed of the screen. It has been pointed out that by such a system, a film, when exposed with intensifying screens, would have only one speed rating and that, therefore, no opportunity to misinterpret speed data would occur. However, such a system has a number of serious disadvantages. First,

a complete listing of the speed characteristics of available films and screens would require three sets of data—one set of speed ratings for films exposed with roentgen rays directly, one set of ratings for films exposed with intensifying screens, and finally one set of ratings for the screens themselves. The duplicity of ratings for films exposed with and without intensifying screens would almost certainly lead to confusion. Of course, this difficulty could be avoided if the same set of film speed ratings could be used regardless of whether the films were exposed with or without intensifying screens, but such a situation requires that the intensification factors of the screens be constant and completely independent of such conditions as the type of film and the quality of the exposing radiation. Since this is not so (5), two sets of film speed ratings are imperative. A second disadvantage is the confusion which would occur if one or more new types of intensifying screen were developed. At the present time, calcium tungstate screens are used exclusively by the profession. However, if screens having spectral characteristics somewhat different than those of calcium tungstate were developed (e.g., zinc sulfide), then an additional set of ratings would be needed for the computation of the speeds of the new film-screen combinations.

From the foregoing, it is evident that separate sets of speed numbers for roentgenographic films and intensifying screens should be avoided. Instead, when a film is exposed with intensifying screens, the film-screen combination should be regarded as a unit with a single speed number assigned to it.

Specification of Unit of Exposure The basic definition of roentgenographic film speed, presented in the preceding section, has little practical usefulness until the unit in which the roentgenographic exposures shall be measured is specified. One unit that will immediately suggest itself is the roentgen. However, such a fundamental unit as the erg/sq. cm might also be considered. In addition, an arbitrary unit,

based on the use of such measuring devices as the photoelectric intensitometer, might prove useful

As far as the erg/sq cm is concerned, this unit is of such small magnitude that it would be rather impractical in general use. Also, a unit based on intensitometric data would have little usefulness, since measurements made with photoelectric intensitometers are extremely difficult to standardize. Accordingly, the roentgen

binations and films exposed without screens would be in the neighborhood of 1,000 and 10, respectively. Such numbers seem inconveniently large and are likely to give a false impression of accuracy. Therefore it has been decided to adopt the deciroentgen (0.1 r) as the unit of exposure in this laboratory's speed definition. Such a unit will yield speed numbers in the neighborhood of 100 for film-screen combinations and 1 for films exposed without screens.

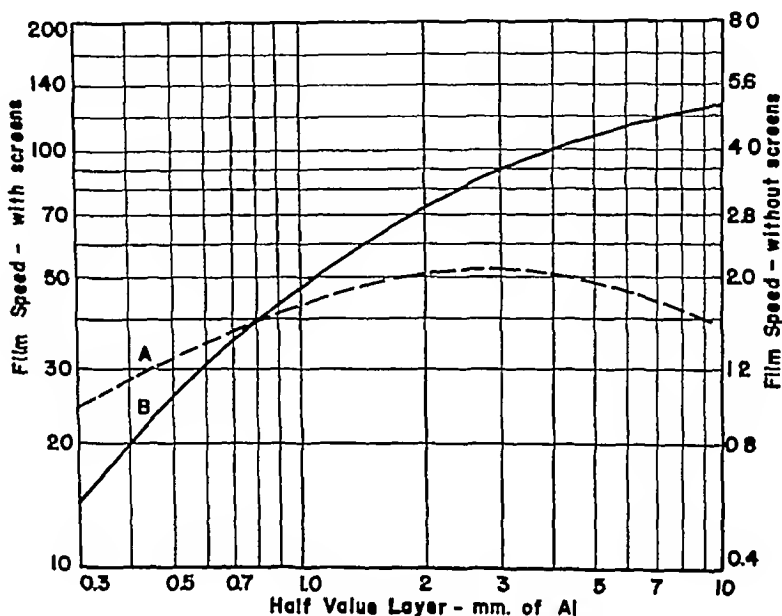


Fig 2—Speed of a typical roentgenographic film exposed to roentgen radiation directly (A) and of a typical film screen combination (B) plotted as a function of the quality of the exposing radiation

remains as the most suitable choice. Actually, it has much to recommend it. Its definition is well standardized and roentgenometric equipment through the years has been developed to a high degree of perfection.

The exposure required to produce a density of 1.0 in present-day roentgenographic films is of the order of 0.001 r when exposures are made with intensifying screens and 0.1 r when exposures are made with roentgen rays directly. Therefore, if the speed of a roentgenographic film were defined simply as the reciprocal of the exposure, measured in roentgens, required to produce a film density of 1.0, the speed numbers of present-day film-screen com-

Specification of Roentgen Quality of Exposing Radiation. The use of the deciroentgen as the unit in which exposures shall be measured immediately requires that the quality of the exposing radiation be specified, for the speed of a roentgenographic film or film-screen combination, determined by roentgenometric testing, is markedly influenced by roentgen quality. This is well shown in Figure 2 where the speeds of a typical roentgenographic film, exposed to roentgen radiation directly, A, and of a typical film-screen combination, B, are plotted as a function of the quality of the exposing radiation (half-value layer of aluminum). These data were derived from sensitometric measure-

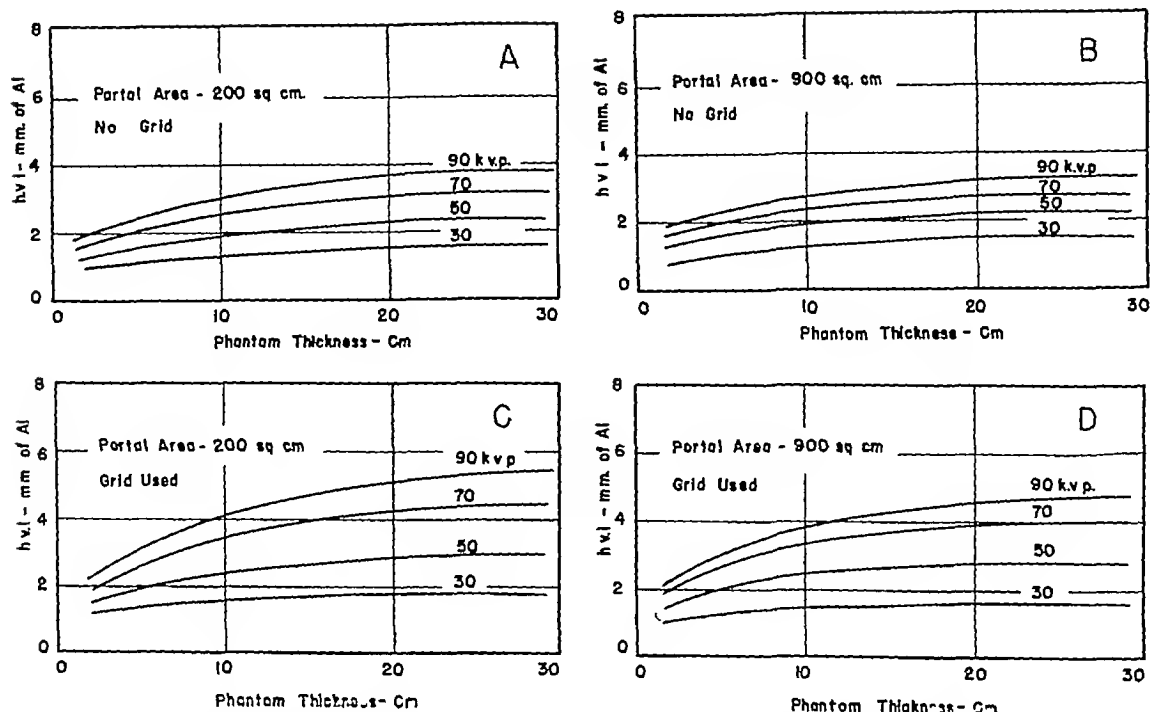


Fig 3 Quality of radiation expressed in terms of the half-value layer of aluminum, transmitted by various thicknesses of masonite presdwood (density = 1.07), for roentgen tube potentials ranging from 30 to 90 kv p for portal areas of 200 and 900 sq cm and for conditions under which a grid of 8:1 ratio is and is not employed below the phantom

ments in which the exposures were recorded in deciroentgens

In an effort to determine what quality of radiation should be specified in the speed definition, the authors measured the half-value layer in aluminum of radiation transmitted by phantoms of masonite presdwood (density = 1.07) ranging in thickness from 0 cm to 30 cm. The incident roentgen radiation was produced by a four-valve, single-phase roentgen generator operating at 30, 50, 70, and 90 kv (peak). The filtration in the roentgen beam included only the wall of the roentgen tube, which had an aluminum equivalence of 0.7 mm. The portal areas of the incident radiation were 200 and 900 sq cm. Measurements were made with and without a grid, having a depth-space ratio of 8:1 and an element distribution of 50 lines per inch. Thus, the measurements were made through a range of conditions approaching those encountered in medical roentgenography.

The data derived from this investigation are plotted graphically in Figure 3. It

will be observed that for conditions approaching those under which roentgenography is performed without intensifying screens (phantoms less than 10 cm in thickness, kilovoltages less than 70 kv p, and small portal areas), the half-value layer of the radiation ranged from 1.0 mm to slightly over 3.0 mm of Al, the average was approximately 2.0 mm of Al. For conditions approaching those under which roentgenography is performed with intensifying screens (phantoms more than 10 cm in thickness and kilovoltages over 50 kv p), the half-value layer of the radiation ranged from 2.0 mm to almost 6.0 mm of Al, the average was approximately 4.0 mm of Al. Thus, it appears that when films are exposed without screens, a half-value layer of 2.0 mm of Al should be specified as the quality of the exposing radiation, when films are exposed with screens, the specification should be a half-value layer of 4.0 mm of Al. However, it will be noted from Figure 2 that the speed rating of the film exposed to roentgen radiation directly is essentially the same at a

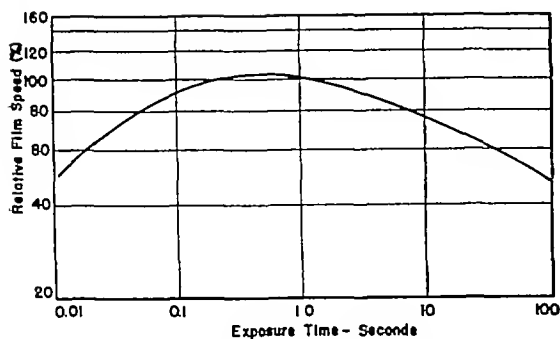


Fig 4 Effect of exposure time on the speed of a roentgenographic film-screen combination

half-value layer of 4.0 mm of Al as it is at 2.0 mm of Al. This is generally characteristic of all films exposed without screens (5). Accordingly, in order to simplify the specification of radiation quality in the speed definition, a half-value layer of 4.0 mm Al has been adopted as the quality of the exposing radiation for both film-screen combinations and for films exposed with roentgen rays directly.

Specification of Radiation Intensity and Exposure Time In practice, the speed of a roentgenographic film may be determined by giving the film a series of graded exposures of known roentgenage, measuring the resulting film densities and plotting a density vs exposure curve. From this curve the exposure required to produce a film density of 1.0 can be readily evaluated and the speed of the film thereby determined from the speed definition.

Now the exposure received by a film is equal to the product of the intensity of the exposing radiation and the exposure time. Therefore, when the film is given its series of graded exposures, exposure can be varied by changing either the intensity of the radiation or the exposure time. However, the speed number of a roentgenographic film-screen combination when determined under one condition will not be identical to that determined under the other, due to the phenomenon of reciprocity law failure (6). Therefore, the method by which the exposure is controlled must be specified in the speed definition.

Under normal roentgenographic conditions, the intensity of the exposing

radiation varies from point to point throughout the film, depending on the structure under examination, whereas the exposure time remains the same at all points on the film. Accordingly, it seems reasonable that, in the determination of the speed number of a film or film-screen combination, exposure be varied by changing the intensity of the exposing radiation and that the exposure time remain fixed.

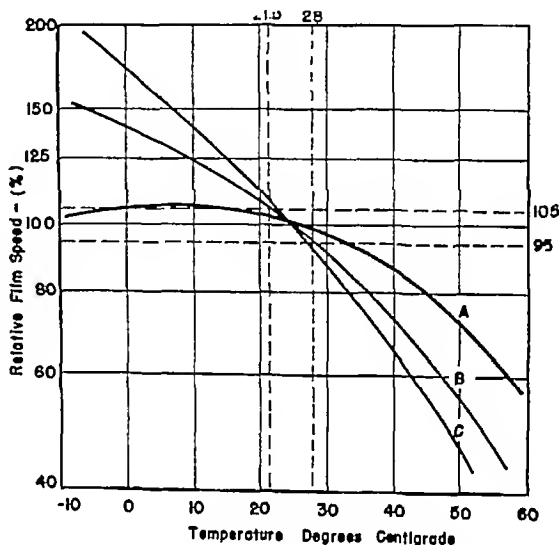


Fig 5 Effect of ambient temperature on the speed of a typical roentgenographic film-screen combination. Curve A exposure time of 0.1 second. Curve B exposure time of 1.0 second. Curve C exposure time of 10 seconds.

Because of reciprocity law failure, roentgenographic film-screen speeds are governed by the length of the exposure time. This is graphically illustrated in Figure 4, in which the speed of a typical film-screen combination is plotted as a function of exposure time. Exposure time, therefore, should not only be fixed at a given level during the measurement of the speed of a particular film but it should be fixed at a specific value for all film speed measurements.

At the present time, the exposure times used in normal roentgenographic practice usually approximate 1.0 second. It therefore appears that the speeds of film-screen combinations should be measured under conditions where the exposure time is 1.0 second. In the future, if high-powered

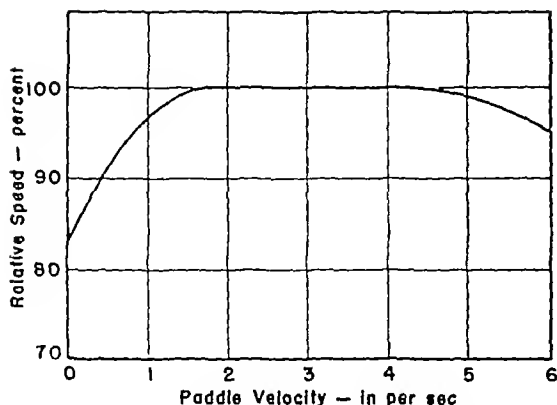


Fig 8 Effect of agitation during development on the speed of a typical film-screen combination

the film surface at a velocity sufficient to remove the end-products of development from the vicinity of the test film. This velocity is determined by measuring the speed of several samples of a test photosensitive material under conditions in which paddle speed is varied through a wide range. The velocity of motion at which the maximum speed of the material is obtained is taken as the optimum paddle velocity, it usually is in the neighborhood of 3.5 inches per second.

The foregoing system of agitation is also applicable to roentgenographic sensitometry. In Figure 8, the speed of a typical film-screen-developer combination is shown as a function of paddle speed. It will be seen that, when no agitation is present, the speed of the film is relatively low. As paddle speed increases, however, the speed of the combination increases, reaches a maximum level which prevails over a relatively wide range, and then slowly diminishes at high paddle velocities. The drop in speed at high velocities apparently is caused by the formation of eddy currents in the developer which prevent the removal of used developer from the film surface. From Figure 8 it seems adequate to require that roentgenographic sensitometry be performed under conditions in which the developer is mechanically agitated by paddles moving at an average rate of 2 to 4 inches per second.

Specification of Drying Conditions Some evidence (8) has been presented in the

literature which indicates that the density of a photosensitive material is affected by the rate at which the material dries after processing. In an effort to determine the effect of drying conditions on the speeds of roentgenographic materials, speed measurements were made on several typical film-screen-developer combinations with the films (a) dried in a cabinet without ventilation and without heating of the air, (b) dried in the open air, (c) dried in a cabinet with forced ventilation and without heating, and (d) dried in a cabinet with forced ventilation and with heating of the air. These various conditions yielded widely different drying rates in the films.

The results of these tests indicate that, under the conditions studied, no significant variation occurred in the speeds of the several materials. It has therefore been decided, for the time being at least, that no specification will be adopted in the speed definition for the drying conditions of films following processing.

Recapitulation From the evidence presented in the foregoing sections the speed of a roentgenographic film-developer or film-screen-developer combination has been defined for sensitometric testing in this laboratory as the reciprocal of the exposure, measured in deciroentgens, required to produce a film density of 1.0 above base and fog under the following exposing and processing conditions:

- 1 The exposure time of the film or film-screen combination shall be 1.0 second.
- 2 The exposing radiation shall have a quality such that its half-value layer is 4.0 mm of Al.
- 3 The ambient temperature of the film and screen during exposure shall be 25° C.
- 4 The temperature of the developer during processing of the film shall be 20° C.
- 5 The time of film development shall be that recommended by the manufacturer of the developer.

6 Continuous agitation of developer, equivalent to that created by paddles moving at an average speed of 2 to 4 inches per second, shall be provided during processing of the film.

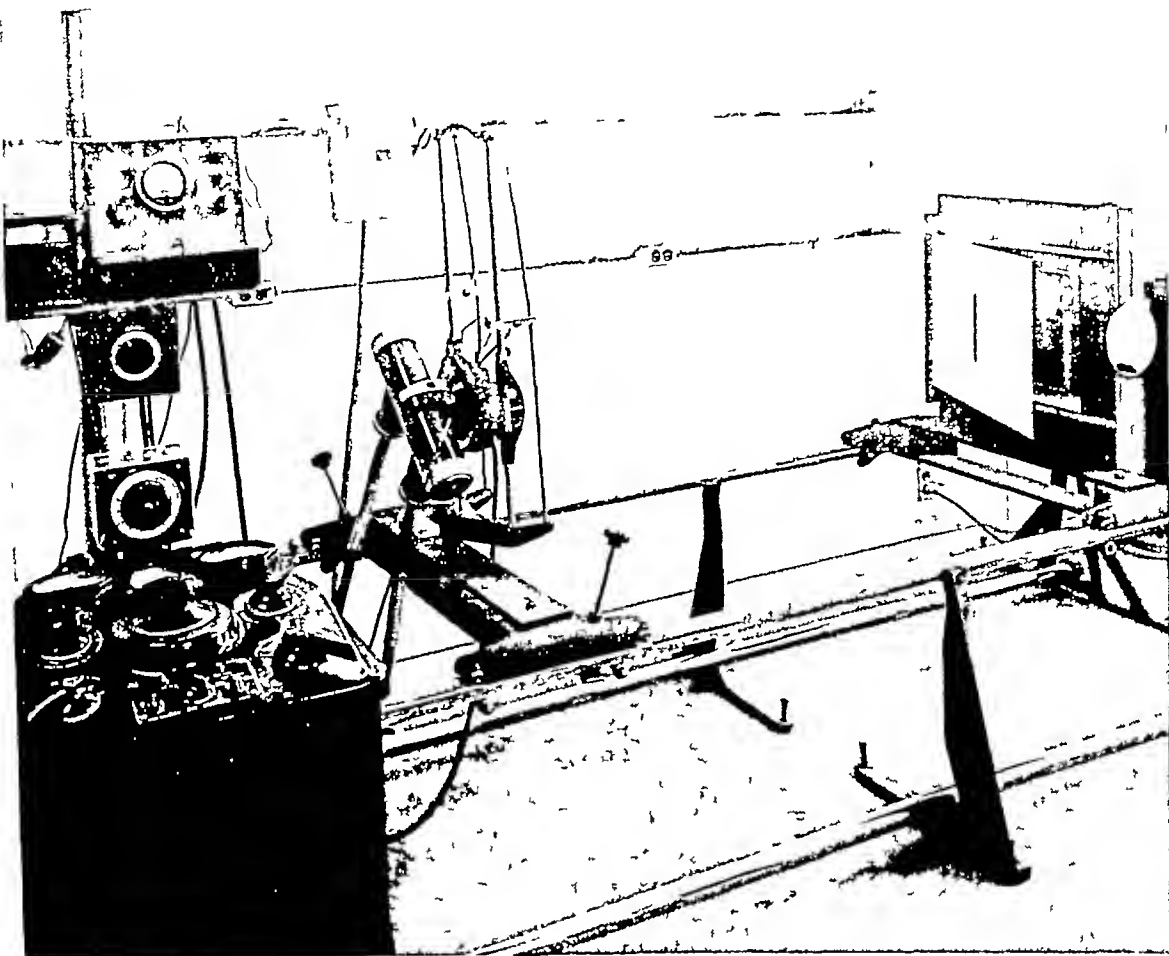


Fig 9 Apparatus for giving graded exposures of measured roentgenage to test films and film screen combinations

This definition is likely to yield speed data that are consistently reproducible under conditions that approach as closely as possible those occurring in normal roentgenographic practice. In a few instances, the specifications of the definition deviate somewhat from conventional procedure. However, these deviations exist only in so far as it is necessary to guarantee reproducibility of results. Doubtless the specifications will require alteration from time to time as changes in roentgenographic procedure occur. These alterations will be made as promptly as warranted.

METHODS OF MEASURING THE SPEEDS OF FILM-DEVELOPER AND FILM-SCREEN- DEVELOPER COMBINATIONS

The roentgen sensitometric laboratory that has been established at Rockville

comprises a pair of specially designed exposing and processing rooms by which roentgenographic speed measurements may be made in compliance with the speed definition discussed in the preceding sections. The exposing room is maintained at a constant temperature of 25°C . The nucleus of the exposing equipment included in the room is a horizontal optical bench (Fig 9) by which graded roentgen exposures may be given to films or film-screen combinations under test. The bench consists of a pair of sturdily anchored tubular rails on which are mounted a film carriage, readily movable from one end of the bench to the other, and a roentgen tube, fixed in position at one end of the device. By varying the distance between the roentgen tube and the film carriage, the intensity of the radiation exposing the films or film-

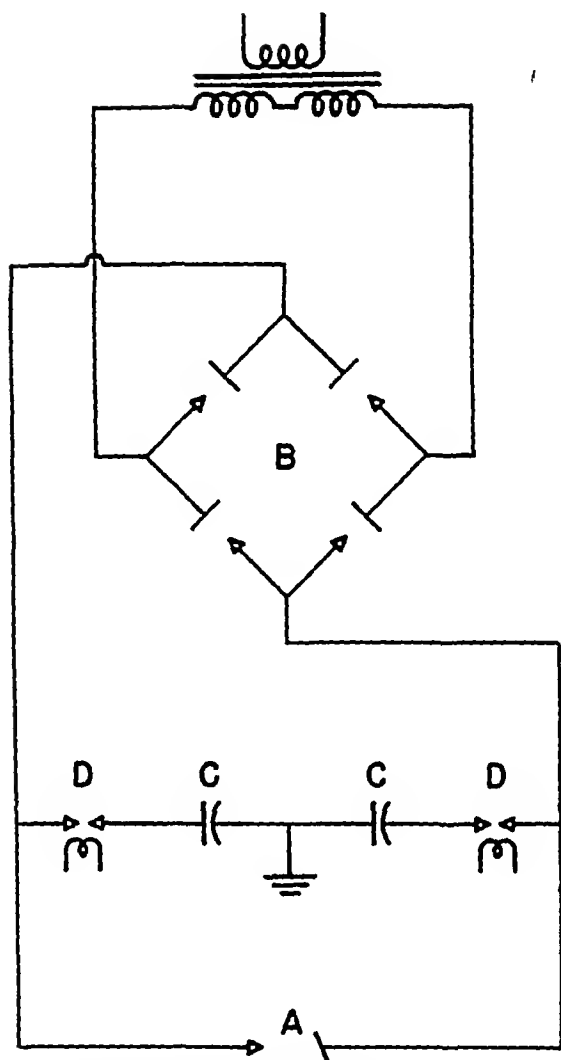


Fig 10 Connection of capacitance to four-valve generator for constant potential output A X-ray tube B Valve tube network C Capacitors D High tension switches

screen combinations may be altered at will

The film carriage includes an 8×10 -inch cassette holder and is covered by a lead protective shield in which a slot, 8 inches long and $1/2$ inch wide, has been cut. Also included in the carriage is a mechanism by which the cassette holder may be moved laterally behind the slot in order that different portions of the test film may be uncovered during successive exposures.

The roentgen tube, a Machlett Aeromax 15, is powered by a constant potential generator consisting of a conventional four-valve single-phase generator with the addition of two 0.015 mfd condensers con-

nected in series across its output terminals. A generator of the constant potential type was chosen for this installation in order to maintain the quality of the exposing radiation as constant as possible. The generator includes a synchronous timer adjusted to produce exposures 1.0 second in duration. Also included in the generator circuit are two high-tension switches (Fig 10) arranged to connect the condensers in the circuit when the exposure is initiated and to disconnect them when the exposure is terminated. These switches prevent a charging surge at the start of each exposure.

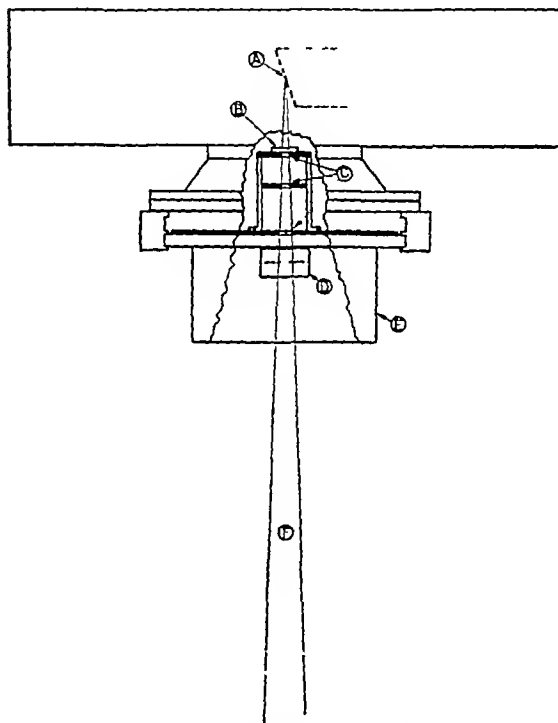


Fig 11 Relationship of roentgen tube and ionization chamber A Roentgen tube target B 4-mm aluminum filter C Collimating ports D Ionization chamber E Shield can enclosing ionization chamber and electrometer tube F Collimated roentgen beam

and a prolonged discharge through the roentgen tube at the end of each exposure. The roentgen tube is operated at a potential of 80 kv, a filter of 4.0 mm of aluminum is located in the roentgen beam. The quality of the resulting radiation is such that its half-value layer is 4.0 mm of aluminum, the quality required by the speed definition.

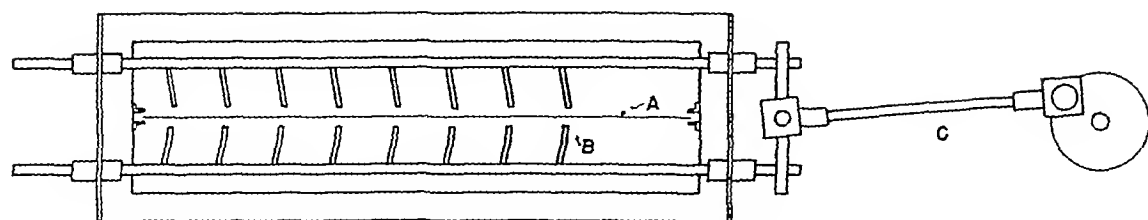


Fig 13 Schematic diagram showing top view of developer agitation mechanism A Roentgenographic film B Paddles C Reciprocating drive mechanism

inverse-square law relating roentgen intensity and tube-film distance. Corrections for air absorption of the roentgen beam are necessary for tube-film distances greater than 50 cm.

After exposure, the film is processed for a length of time recommended by the manufacturer of the developer and, when dry, is measured densitometrically. Corrections are then applied for fog density according to the Wilsey (9) formula, and the resulting densitometric data are plotted graphically as a function of the quantity of exposing radiation. Thereupon, a curve is drawn through the several points and the exposure in deciroentgens necessary to produce a film density of 1.0 is determined. The reciprocal of this exposure value is the speed of the film-developer or film-screen-developer combination.

At the present time, speed data on commercially available films, screens, and developers are being collected as rapidly as possible. As this material comes to hand it will be published in *Public Health Reports*. From time to time it is hoped that summary reports will also be published in the roentgenological journals.

SUMMARY

A roentgen sensitometric laboratory has been established by the U S Public Health Service to measure the speed characteristics of the commercially available films, screens, and developing materials used in medical roentgenography. The data are collected by determining under

rigidly controlled conditions the exposures or quantities of roentgen radiation, measured in deciroentgens, necessary to produce film densities of 1.0 in the film-developer or film-screen-developer combinations under test. The speeds of various combinations are then calculated from the reciprocals of the exposure data.

As the laboratory proceeds with its program, information on the speed characteristics of many roentgenographic films, screens, and developers will be published regularly. It is hoped that such information will not only be of technical value to roentgenologists but will also constitute a constant stimulus to the roentgen industry to improve its products.

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SUMARIO

La Sensibilimetría de la Películas y las Pantallas Roentgenográficas

El Servicio de Sanidad Pública de los E U A ha establecido un laboratorio roentgenosensibilimétrico para medir las características de velocidad de las películas, pantallas y sustancias reveladoras empleadas en la roentgenografía médica y puestas a la venta. Los datos se compilan determinando, en condiciones rígidamente comprobadas, las exposiciones o cantidades de irradiación roentgen, medidas en decirroentgens (0.1 r), que se necesitan para producir densidades de película de 1.0 en el revelador de películas o en las combinaciones de reveladores de películas-pantallas en vías de comprobación. Las condiciones estipuladas son: tiempo de exposición, 1.0 segundo, calidad de la irradiación de exposición tal que su capa de hemirreducción sea 4.0 mm de aluminio, temperatura

durante la exposición, 25° C, temperatura del revelador, 20° C, tiempo de revelado, el recomendado por el fabricante del revelador, agitación continua del revelador equivalente a la creada por paletas que se movieran a una velocidad media de 5 a 10 cm por segundo. Las velocidades de varias combinaciones se calculan por las recíprocas de los datos de exposición.

A medida que el laboratorio prosiga con sus planes, publicará con regularidad datos relativos a las características de velocidad de muchos reveladores, películas y pantallas roentgenográficas esperando que esta información no sólo sea de valor técnico para los radiólogos sino que constituya un constante aliciente a la industria roentgenológica para mejorar sus productos.



Relationships Between Chemical and Biological Effects of Ionizing Radiations¹

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IN RADIOBIOLOGY we are interested in chemical effects of ionizing radiations only in so far as they may be involved in biological effects.² As background for discussion of this relationship, let us briefly review the general state of our knowledge (or ignorance) of mechanisms of radiobiological actions.

1 The first event in such an action is, of course, the absorption of radiant energy by molecules in the biological object or its medium. The molecules which thus acquire energy in excess of normal are said to be activated. Some absorb so much energy that electrons are ejected, these molecules are said to be ionized. Others absorb less energy, electrons are merely shifted to other orbits, such molecules are said to be excited. The foregoing physical processes are at present fairly well understood, and many aspects of them can be described quantitatively.

2 After the absorption of energy, our knowledge of the radiobiological action is practically zero until the biological effect occurs. This effect—depending upon the biological object irradiated, the conditions of irradiation, the technic of observation, and a multitude of other factors—may be the mutation of a gene, the breaking of a chromosome, an increase in permeability of a membrane, an inhibition of cell division, a leukopenia, induction of a neoplasm, death of an animal, or any one of many other radiobiological phenomena. In all these diverse cases, however, there is no apparent resemblance between the biological effect and the initial physical phe-

nomena associated with the absorption of energy.

3 From the foregoing considerations, it is evident that, during the so-called "latent period" which intervenes between the energy absorption and the observation of biological effect, a chain of important connecting events must occur. So far as I am aware, the specific nature of these events is in all cases unknown, as is also the number of successive events in the chain. However, *in general* it appears highly probable—and most physicists and radiobiologists have long considered it almost axiomatic—that at least the early events in the chain are chemical.

Indeed, it is exceedingly difficult to imagine a mechanism of radiobiological action which does not involve chemical changes. The biological end-effects are changes in either physiology or morphology, these terms being used in the broad sense. The physiological changes clearly are changes in cell chemistry or are the results thereof. Moreover, when we recall that biological structures are built by chemical means, we can hardly imagine a morphological change which does not involve chemical change. Let us also consider the early part of the mechanism of radiobiological action. The high-energy radiations can ionize any type of molecule, and we may be confident that many kinds of molecules in the cell are thus highly activated under irradiation. Once a pair of ions is formed, they may do one of two things. They may recombine, in which case no change is produced in the cell.

¹ Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif. Dec. 5-10, 1948.

It might be helpful to comment on the terms "biological" and "chemical" as used here. Biological structures of course consist of chemical substances, and biological activities are made up of chemical and physical processes. When we know something of the molecules involved in the structures and processes we usually speak of chemical composition and chemical reactions. When we are ignorant of the molecules involved we fall back on the term "biological."

Or they may form new combinations, either with other radiation-produced ions or, more likely, with the much more numerous non-activated molecules in the cell. This production of new combinations is, by definition, chemical reaction. In other words, it would appear, from this type of reasoning, that chemical reaction is the only way in which the initial physical act of ionization may start any kind of change in the biological object.³ This conclusion is substantiated by numerous experimental observations that various cellular constituents, ranging in complexity from molecular oxygen to the most complicated proteins, undergo chemical change when irradiated *in vitro* in aqueous solution.

Henceforth I shall assume that chemical effects do intervene between energy absorption and observation of the biological effect. There remain to be discussed (a) the nature of these chemical reactions and (b) the manner in which they lead to the biological effect.

How many kinds of chemical reaction are directly initiated by irradiation of a living cell? At first thought, the upper limit on the number of possible ones would appear to be enormous, because (a) the known kinds of molecules in a cell number at least in the hundreds, and the total is probably much greater, (b) the ionizing radiations are capable of activating any of these many molecular species, and (c) there is the possibility that any type of activated molecule may react with any type, activated or non-activated, in the cell.

Actually, the foregoing considerations lead to an exaggerated estimate of the number of kinds of reactions produced. In the first place, many kinds of molecules will not be affected. For instance, 1,000 roentgens of γ -radiation ionize only about one molecule in ten million in a typical cell. Accordingly, those molecular species

which occur only in small numbers per cell⁴ stand a high probability of not being ionized and of not being close enough to an ionized molecule to react with it before it reacts with something else. In the second place, some of the possible new combinations of ionized molecules with other molecules are energetically impossible or highly improbable.

However, despite these factors tending to reduce the actual number of kinds of reaction, the figure still is probably quite high. This, occurring at the outset of the radiobiological action, makes the unraveling of the mechanism appear at first glance practically hopeless. The situation does not seem so bad, however, when one reflects that, after all, not all the types of reaction which occur are necessarily involved in any given biological effect. That this must indeed be true is supported by the following observations.

First, for several diverse biological effects (11, 19, 20, 23) it has been demonstrated that irradiation of the cell nucleus is far more effective than irradiation of cytoplasm. Accordingly, in such cases, we can locate the pertinent reactions, or at least the early ones, in a definite morphological fraction of the cell. Second, when different radiobiological effects are studied in the same species of cell, it is sometimes found that the quantitative relationships between dose and the various effects can be altered in different ways by the same agent. For instance, Gray and his co-workers (9, 10) studied the effectiveness of various radiations in lethal action and in inhibition of mitosis in the root of the broad bean. They found that for both effects the efficiencies of the radiations varied with their specific ionization,⁵ but that the quantitative relations between efficiency and specific ionization were drastically different in the two cases. Another instance. Crabtree (3) used variations in temperature to alter the partial inhibition

³ Similar reasoning can be applied to the excited (but not ionized) molecules. These may lose their activation energy by some process which restores the molecule to normal—e.g., emission of low-energy radiation—or they may react with other molecules and undergo chemical change.

⁴ It is to be remembered that many molecular species of extreme importance (genes) occur only one or two per cell.

⁵ This is discussed later in more detail.

by radiation of various metabolic processes in surviving tissues. All of the radiobiological effects varied quantitatively with temperature, but in widely different ways.

Experimental results like those just described are completely unexplainable on the assumption that all types of radiation-induced chemical reactions in the cell contribute significantly to each biological effect. On the other hand, they are completely consistent with the view that each biological effect is due to a limited number of specific types of reactions. Reaction types which play a role in a given biological effect are termed *relevant* to that effect. All others are *irrelevant* to it, although certain ones may be relevant to other effects in the same biological object.

When do the relevant reactions occur? The first ones must occur very soon after the ions are formed, because the average life of an ion is a millionth of a second or less. If reaction does not occur within that time, the ions recombine and no net change occurs. The later relevant reactions obviously take place during the remainder of the "latent period," which, depending upon the nature of the biological effect and the technique of observation, may last anywhere between a few minutes and a few decades.

It is of further interest to consider the location of the relevant reactions. It is plain that the very first ones must occur close to the locations of the ions immediately after their formation, because the short life of the ions permits them little time to diffuse or otherwise be moved away. From the ionization process we obtain a very light negative ion (the ejected electron) and a heavy positive ion (the residual molecule). Usually the energy absorbed is somewhat greater than that required to eject the electron, and the excess appears as kinetic energy of the two ions, their movement being in opposite directions. Because of its relatively great mass, the positive ion gets a very small fraction of this energy and stays practically at the point where ionization takes place (except for the influence of diffusion and convec-

tion, which must be small during the life of the ion). The negative ion (electron) accordingly gets practically all of the kinetic energy and, being light, it starts off with fair velocity and may go some little distance (on a molecular scale) before it is brought to thermal equilibrium by collisions with neighboring molecules. Thus the positive and negative ions are separated immediately after formation. Lea calculates that this separation is of the order of 15 millimicrons in the case of an alpha-particle track in water (16).

The foregoing spatial considerations are concerned with events on a molecular scale. Let us now consider the sites of reaction on a larger scale. If the first reactions occur near the points where ions are formed, then the sites of the individual early reactions must have substantially the same distribution as the ionizations. About this we have considerable information. Wilson cloud-chamber photographs, which record the location of ions in gases, show that the ion pairs are not produced singly at random in an irradiated volume but are distributed along the tracks of the speedy ionizing particles (electrons or atomic nuclei) which either constitute the primary radiation (*e g*, alpha or beta rays) or are secondary to other types (*e g*, γ , gamma, or fast-neutron rays). Moreover, these photographs reveal considerable information about the distribution of the ion pairs along the tracks. They are not always single but are frequently in clusters consisting of two or more pairs, the average number being three (13). The clusters, moreover, are not uniformly spaced along the tracks but are closer together the less the speed of the ionizing particle. This means that the ion pairs are, on the average, closer together near the end of the track than at the beginning.

The number of ions produced per unit length of track of ionizing particle is called the *specific ionization* or *linear ion density*. Not only does it vary along the track of an individual ionizing particle, but it is widely different at comparable positions along the tracks of different types of particles,

e.g., electrons and alpha particles. Although the Wilson photographs, it is true, reveal the foregoing facts about ionization tracks in gases only, additional physical data and theory make it relatively safe to assume that the picture in an irradiated cell is substantially the same, except reduced in dimensions about a factor of a thousand.

In view of the marked differences in distribution of the ion pairs, and accordingly of the early chemical reactions, along the ionization tracks, one might wonder whether this distribution might affect the efficiency of the radiation per ion pair, or, putting it otherwise, alter the biological effectiveness of the early relevant reactions. This is indeed the case. Over a hundred investigations are to be found in the literature, in each of which two or more radiations producing substantially different specific ionization were used in producing the same biological effect. In practically all of these experiments the various radiations were found to vary in biological effectiveness with their specific ionizations. (See reference 25 for review.)

Looking at the picture on a microscopic rather than submicroscopic scale, we may make a few more comments about the location of the early relevant reactions. It has already been mentioned that fractional irradiation of parts of cells has shown that, in production of several different biological effects, ions produced in the cell nucleus are much more effective than those produced elsewhere. In these cases, the early relevant reactions obviously take place in the nucleus, although in some cases the end-effects—*e.g.*, inhibition of chlorophyll formation (23)—are observed outside the nucleus.

Let us consider another example of locating the early relevant reactions. Various types of chromosome aberrations have been much studied and have been reviewed by Lea (15) and by Catcheside (2). All of them can be shown, by cytogenetic methods, to be due to breaks induced either in chromosomes or half-chromosomes (chromatids). Accordingly, the radiochemical

reactions of interest are those relevant to breaks. The highly localized nature of the breaks strongly suggests that all the relevant reactions occur very close to the location of the break and, indeed, probably originate with ions produced along a track which passes through or very near the chromosome. However, this assumption, unsupported, turns out to be rather naïve when it is found that certain dissolved substances, such as nitrogen mustards, can also produce chromosome breaks. Since these chemicals certainly are not *applied* locally to portions of chromosomes—even though they might *concentrate* in such a fashion—it is plain that radiation might produce a substance extrachromosomally which nevertheless could produce the breaks.

To support the idea of early relevant reactions in or near the chromosome, more evidence is needed, and it is now available in apparently sufficient amount. Rather typical of this evidence is the following (2). To produce certain types of chromosome aberration (exchanges), it is necessary that both chromosomes be broken. When these aberrations are produced by fast neutrons, their number varies directly with dose, but when produced by x-rays the number varies with the square of the dose. Now, if the relevant reactions occur distant from the chromosomes, either of these two dose-effect relationships would be consistent if it held for *both* types of radiation, because the hypothetical substance producing the breaks would have to diffuse a considerable distance and accordingly there should be no appreciable effect of the submicroscopic differences in distribution of the ions and the early relevant reactions produced by the two types of radiation. However, since the dose-effect relations are not the same, the only way in which distant reactions can still be invoked is to postulate *different* relevant reactions, and this seems to be highly unlikely. In contrast to all these difficulties, it is easy to explain the observed *dose-effect* relations in terms of relevant *reactions* in the chromosomes. If *one*

assumes that the neutrons, known to produce a relatively short length of dense ionization tracks, break both chromosomes simultaneously, while the λ -rays, known to produce a great length of sparse tracks, break only one chromosome at a time, the two types of dose-effect relation are mathematically predictable. Such an assumption, of course, implies highly localized relevant reactions. Since the assumption is logically tenable, the idea of localization of the reactions is supported.⁶

As a further example of locating the early relevant reactions, we may consider certain biological effects which are reduced in amount by adding certain organic substances to the medium of the cell for the duration of irradiation (5, 17). Since some of these substances (*e g*, proteins) almost certainly do not penetrate the cell membrane, it seems reasonable to conclude that, in the production of these biological effects, the early relevant reactions must occur in the medium rather than in the cell. Later relevant reactions must, of course, occur at the cell surface (or possibly even inside the cell after cellular absorption of products of the early relevant reactions).

Let us now consider the chemical nature of the relevant reactions. Here we must invoke our present knowledge of the chemical constitution of the cell, of the radiation chemistry of its constituents *in vitro*, and of the natures of the biological end-effects.

The end-effects observed are mostly deleterious and are usually qualitative abnormalities—such as chromosome aberrations or inhibition of cell division—although quantitative changes in normal cellular processes are also sometimes ob-

served. There are two general means by which such changes might be accomplished: (a) the chemical *destruction* of an important molecular species, such as an enzyme, vitamin, or gene, and (b) the *production* of a molecular species which, in the broad sense, acts as a stimulus to the cell—for instance, a poison such as the much discussed hydrogen peroxide. In the latter case, the molecular species produced might be completely new to the cell or it might be normal to the cell but produced in excess. In any event, either a destruction or a production must be accomplished through chemical changes in molecules normally in the cell.

As pointed out earlier, any kind of molecule present in the irradiated cell may be ionized and accordingly stands a chance of being chemically altered. There is, however, one molecular species which is several times as abundant as all others taken together—the water molecule. Most of the molecules ionized are water molecules. Can a biological end-effect be due to a destruction of water molecules, thus depriving the cell of part of its water? This seems highly improbable. It has already been remarked that a reasonably large exposure (1,000 r) ionizes only about one molecule in ten million. If one ion pair should result in the destruction of one water molecule—and it appears unlikely that the yield of the reaction would be of a higher order of magnitude—the fraction of the water destroyed would be negligible from the standpoint of deprivation. Even if the yield were surprisingly high and a fairly large fraction of the water were thus removed from the cell, in most cases the cell would merely absorb water from its medium until the deficit was restored.

On the other hand, the ionized water molecules (or products of their reactions) might undergo relevant reactions with other cellular constituents. Indeed, in numerous investigations (*e g*, 8, 4, 7) it has been found that various cell constituents, ranging in complexity from molecular oxygen to enzymes, are altered if irradiated when dissolved in water, and

⁶ It may be noted that chromosome breaks appear to be effects which can be handled by the target theory, one feature of which is the assumption that the pertinent radiobiological events are localized in small (usually submicroscopic) volumes in which "hits" must be produced. It is sometimes stated that the idea of relevant radiochemical reactions conflicts with target theory. However, there appears to be no conflict if one visualizes the relevant reactions occurring in highly localized fashion at various points along the ionization tracks. If enough relevant reactions occur close enough to an important small volume they constitute a hit. Some biological effects may result from hits, others from less localized relevant reactions.

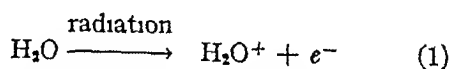
that the quantitative relationships are consistent with the idea that they are altered by reaction with products formed from water. The radiochemical yield is independent of concentration of solute so long as the molecules of dissolved substance are few in number compared to those of the water, the concentration of solute can be changed within wide limits without changing the number of molecules undergoing chemical reaction per unit dose. This is called the "dilution effect." It is, of course, unexplainable on the assumption that the solute molecules react as a result of their own ionization, for in such case the number of molecules changed per unit dose should be strongly dependent upon solute concentration, rather than independent, as observed. On the other hand, it is completely consistent with the view that the solute molecules react with ionized water molecules or reaction products resulting from them.

Substantiation of this latter view is furnished by the so-called "protection effect." When to a solution containing a single solute a second solute is added (e.g., 4, 7), it is frequently observed that the number of molecules of the first solute changed per unit dose is reduced, and that the extent of this "protection" depends upon the relative concentrations of the two solutes. This is, of course, exactly what would be expected if the two solutes were both capable of reacting with the same product (or products) of water ionization and were competing for it. It is interesting to note a biological parallel, namely, that, in studying inhibition of fertilizing ability of sea-urchin sperm, Drs. Evans and Failla and their co-workers (5) have observed both the dilution effect and the protection effect.

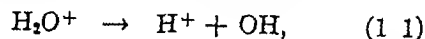
I do not mean to imply in the last few paragraphs that all radiochemical reactions in cells must be initiated by ionization of water and are therefore of an indirect type. Direct reactions, due to ionization of the solute, must occur, although the yields are likely to be small compared to the indirect effects. Indeed, such solutes as enzymes

can be chemically changed by irradiation in the dry condition, but the doses required to change a given percentage are usually greater by a factor of some hundreds or thousands than the ones equally effective on the same substance in dilute aqueous solution. Again it is interesting to note a biological parallel. Structures such as spores and seeds are much more resistant when dry than when moistened (12, 14).

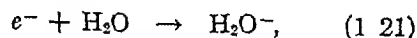
Whatever may be the ultimate answer to the question of relative radiobiological importance of direct and indirect reactions, there is no doubt that at present most radiobiologists find the indirect reactions the more exciting, not only because of the reasons given above but also because their postulation appears the more fruitful in terms of new experiments suggested and designed. A great stimulus has been given this field by the recent theory of Weiss (21), according to which the ionization of water results in the formation of free hydroxyl radicals and hydrogen atoms which then undergo reactions with cell constituents, at least some of which are relevant to the end-effect. The main events, according to Weiss, are as follows. The passage of an ionizing particle ionizes water



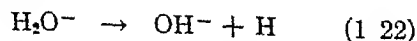
The positive water ion dissociates,



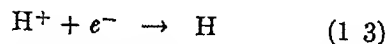
forming a hydrogen ion and a hydroxyl radical. The electron becomes attached to a normal water molecule,



and the resulting negative water ion dissociates to yield a hydroxyl ion and a free hydrogen atom

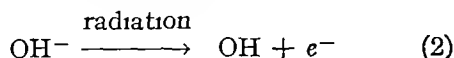


The electron may alternatively, but probably rarely, combine with a hydrogen ion to form a free hydrogen atom



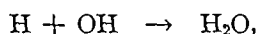
In addition to the foregoing reactions fol-

lowing the ionization of water, OH radicals may be formed by ejection of electrons from hydroxyl ions normally present in water

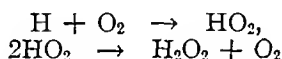


The resulting electron may, of course, produce H atoms by reactions (1 22) and (1 3). Since OH⁻ ions are much less numerous than water molecules, reaction (2) probably occurs much less frequently than reaction (1).

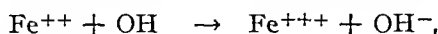
After the hydroxyl radicals and the hydrogen atoms are formed, what can be predicted about their further history? If they are close enough together, they may recombine (21)



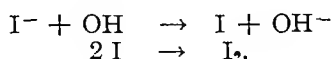
with the result that no net change occurs. However, as Lea has pointed out (16), the distance between H and OH is usually so large on a molecular scale that other things are likely to happen before diffusion brings them together. Some of the other things which may happen are as follows. If molecular oxygen is present (and it is in most cells), hydrogen peroxide may be formed by action of the free hydrogen atoms



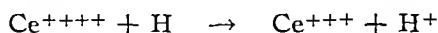
Many investigators have observed H₂O₂ production in water containing oxygen, and the formation of this poison has often been invoked as a mechanism of radiobiological injury. Other reactions which may occur are oxidations such as ferrous to ferric ion,



and iodide ion to iodine,



and reductions such as ceric to cerous ion,



These oxidation-reduction reactions and many others have been observed to occur in irradiated aqueous solutions, and since it is well known that many important cell

constituents, such as sulfhydryl-containing compounds, may be functionally changed by oxidation or reduction, it seems highly plausible that reactions of this type may be radiobiologically important.

Until a few years ago, there was a serious difficulty in accepting the reactions observed *in vitro* as relevant to biological effects. This was the fact that in general the doses required to produce biological effects were tens or hundreds of times smaller than those required to produce an amount of chemical change which plausibly might cause biological change. However, Dale (4) and others have recently shown that certain cell constituents (chiefly enzymes), when highly purified and irradiated in dilute aqueous solution with 100 r or less, are inactivated to an extent which conceivably might produce biological changes. There is still the objection that the irradiation *in vitro* does not accurately tell us what would happen quantitatively to the same substance when irradiated in a living cell, where all manner of protective (competing) substances might be present. However, the experiments prove that at least some important cell constituents are intrinsically radiosensitive enough that their radiochemical reactions in the cell might be relevant to biological effects.

Another glimpse of a possible explanation of radiosensitivity *in vivo* is furnished by the very recent work of Mazia (18), who finds not only that the enzyme pepsin is very radiosensitive when irradiated in a monomolecular film consisting of enzyme plus substrate (egg albumin), but that the sensitivity is markedly decreased by increases in surface pressure which may be expected to alter the structure of the film. This gives us a hint that morphology on the molecular scale may have much influence on radiosensitivity.

From the foregoing discussion we see that many radiochemical reactions of cell constituents are known to occur *in vitro* and that it appears reasonable that at least some of these known reactions, and probably many additional unknown ones,

occur in an irradiated cell. If we are interested in one certain biological effect, can we identify one or more of these many reactions as relevant to that effect? Such is our present state of ignorance that I must regretfully admit that I know of not a single case in which such relevance has been unequivocally established. And yet, obviously this is a step which we must learn to take in radiobiological research if we are to make substantial progress in understanding mechanism.

In view of the importance of the subject, it might be profitable to inquire: What is required to establish relevance? The minimal procedure would seem to be as follows. First, a specific radiochemical reaction must be suspected of relevance to a given biological effect. Second, if the reaction is known only *in vitro*, it must be proved to take place in the irradiated cell⁷ and, moreover, it must occur *before* the biological effect. Third, if the reaction passes the foregoing preliminary tests, it must be *connected* with the biological effect.

The first of these three steps is comparatively easy and has been taken many times. In practically every case where a known cellular constituent has been altered by irradiation *in vitro*, this reaction has been suspected of relevance to biological effects. The second step is much more difficult, because it involves qualitative chemical analysis in the intact cell. However, it does not appear entirely hopeless, we may take encouragement from work such as that of Caspersson (1), who analyzes for such substances as proteins and nucleic acids in the intact cell.

The third step is perhaps the most difficult. By what procedure can connection be demonstrated? In general, there would seem to be a direct method and an indirect one. Given an indefinite amount of time, the direct approach might work. It consists of working out in detail the history of the molecules in the cell from the moment of absorption of radiation to the time of observation of the effect. This obvi-

If the relevant reactions occur in the medium rather than in the cell the general argument is unchanged.

ously is the desirable way to do it because, not only is connection proved, but the entire mechanism of radiobiological action is revealed. However, such a method involves technique and a knowledge of cell chemistry and physics which are unavailable today and probably for many years to come. In fact, today the chance of using this method appears fantastically improbable.

On the other hand, connection might be established with a fairly high probability by an indirect method. If, by a variety of means, the dose required to produce a given degree of the observed biological effect can be varied to a readily measurable extent, and if the yield of the radiochemical reaction can be shown to vary, both in direction and extent, in a manner consistent with its being the causation of the biological effect, then we may deduce that connection has been established with a reasonable degree of probability—at least with probability sufficient to justify the risk of further experimental time and effort.

Let us consider an example of the application of the above three steps in establishing relevance. It was early suspected that alteration of proteins might be relevant to biological effects, and when irradiation of certain protein solutions *in vitro* (6, 22) resulted in flocculation, the first step had been accomplished, a reaction known to occur *in vitro* was plausibly suspected of relevance. So far as I know, nobody has yet demonstrated flocculation of proteins in the cell, the second step is accordingly not yet accomplished. Nevertheless, a beginning has been made on the third step. When, during irradiation, the intracellular pH of *Drosophila* eggs or germinating fern spores (24) is modified in graded fashion by exposure to various concentrations of penetrating acids and bases such as carbon dioxide, hydrogen sulfide, and ammonia, it is found that their radiosensitivity exhibits maxima at definite concentrations of acid or base. This behavior has a striking resemblance to that of proteins *in vitro* because their

flocculation is maximal when the pH of the medium is kept at or near the isoelectric point during irradiation. Here is a crude beginning of the third step, the biological effect and the suspected radiochemical reaction being connected by virtue of the observation that the dose-effect relations are changed in the same unusual fashion by graded alteration of the same experimental factor. The third step is, of course, far from satisfactorily complete, connection needs to be demonstrated by altering the dose-effect relations by changes in other experimental conditions such as dose rate, specific ionization, temperature, etc. Moreover, the third step cannot be completed until the second step—demonstration of radiochemical flocculation in the cell—has been accomplished.

As investigation proceeds as indicated above, it may well result, in this instance, in a proof of irrelevance rather than of relevance. Nevertheless, the example given illustrates the sort of laborious procedure which may be used in arriving at an understanding of the mechanisms of radio-biological actions.

Today, with ionizing radiations becoming more and more prominent as a factor in our everyday environment, it is vital that we come to understand these mechanisms. It is evident that the difficulty of our attaining such understanding is indeed formidable, yet it is not necessarily discouraging. It is, indeed, extremely gratifying to see the present surge in radiobiological research in this country and elsewhere. At present our chief handicap in this research is shortage of personnel, especially of certain types. We have never had enough physicists in radiobiology and we are shorter than ever today, considering the increase in radiobiological effort. Moreover, it is now evident that if we are to work out the radiobiological mechanisms, we must have chemists. At present there are scarcely any in the field. Somehow, the important opportunities in radiobiology must be brought to

the attention not only of biochemists but also of physical and organic chemists.

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SUMARIO

Relaciones entre los Efectos Químicos y Biológicos de la Radiación Yonizante

Como el protoplasma es un sistema acuoso, la química de la irradiación de las soluciones acuosas reviste interés particular por la luz que puede lanzar sobre los mecanismos de los efectos radiobiológicos. Ciertos fenómenos, tales como el efecto de dilución y el efecto de "protección," observados comúnmente en las soluciones acuosas irradiadas de sustancias inorgánicas y orgánicas simples, han sido también observados después de la irradiación de solucio-

nes de enzimas y virus y de suspensiones de células aisladas. Además, ciertos factores experimentales, tales como el pH y la yonización específica, afectan de modo semejante la efectividad química y biológica de las radiaciones yonizantes.

Es importante llevar los aportes de la radiobiología al conocimiento, no sólo de los bioquímicos, sino también de los fisio- y los organoquímicos.



Structural Differences in Bone Matrix Associated with Metabolized Radium¹

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THE METABOLISM of radium in the body has been a matter of concern since attention was first directed to radium poisoning by Blum (1) and Martland (2). Subsequent investigations (3, 4) have confirmed early suggestions that radium ab-

dearth of quantitative data associated with observable physiological effects. So far as is known, no suitable rapid method of preparing the hundreds of bone sections necessary for such studies has been developed. The advent of nuclear energy and

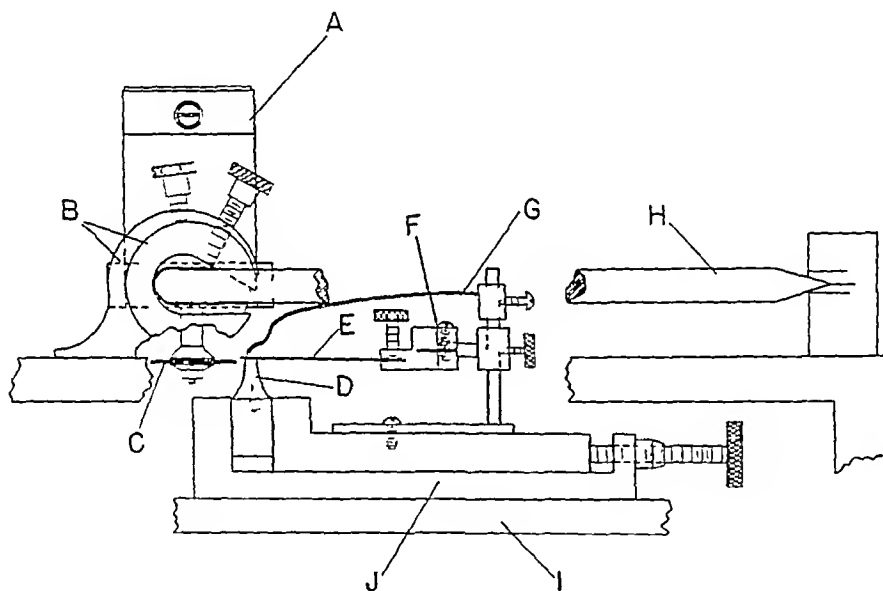


Fig 1 Details of bone sectioning instrument. A Motor. B Motor mounting blocks which permit rotation of the motor about a horizontal axis perpendicular to the plane of the paper. C Saw blade. D Bone mounted in bioplastic. E Flexible cover slip resting on upper surface of bone to retain cut section. F Cover slip clamp. G Wire for adjustment of pressure between cover slip and bone. H Index arm for adjustment of attack angle of saw. I Carriage way. J Bone carriage.

sorbed by an animal is eventually deposited in the skeleton. A few autoradiograms of human and experimental animal bones have shown that the radium is not uniformly distributed, but no quantitative measurements of its distribution have been published. Considerable uncertainty as to radium tolerance exists because of the

the possibility of human radioactive contamination have served to emphasize the need for such studies and for techniques by means of which they can be made.

This paper presents preliminary results of studies of the distribution of radium in certain rat bones containing metabolically deposited radium. It describes, also, re-

¹ Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif. Dec 5-10 1948.

cently developed bone sectioning and autoradiographic technics which greatly facilitate the study of the distribution of radioactive substances in bone

Material for study was prepared by intraperitoneal injection of radium chloride in physiological saline into 12-week-old Wistar rats. The distribution of the radium which was metabolically deposited in the bones of these rats was studied autoradiographically through alpha-particle tracks in nuclear track plates (Eastman NTB). So far, tibias and femurs have been chiefly studied. The matrix of these bones has been examined microscopically and photomicrographically for changes in structure and for differentiated areas associated with radium deposits.

EXPERIMENTAL TECHNICS

The microscopic investigation of radium distribution in bone and its relation to the cellular structure of the bone matrix required the development of a new method of bone sectioning. Such studies demand the examination of hundreds—perhaps thousands—of bone sections. Older methods of preparation were much too slow and laborious. Moreover, in many cases bones from animals as much as two years old were studied, and the method described by Axelrod (5) is not easily applicable to old bone.

(1) *Bone Sectioning Method* To eliminate the difficulties mentioned above, a method of cutting sections of uniform thickness, thin enough for microscopic and photomicrographic examination, has been developed. A small circular saw blade, an inch in diameter and 150 microns thick, mounted on the shaft of a small, variable speed motor, was substituted for the knife blade on a brain microtome. Figure 1 is a diagram of the essential constructional features, while Figure 2 is a photograph of the instrument.

Several precautions must be taken in order to ensure uniform thickness of cut sections. The motor armature must be ball-bearing mounted to prevent end play, and the motor mounting must be very

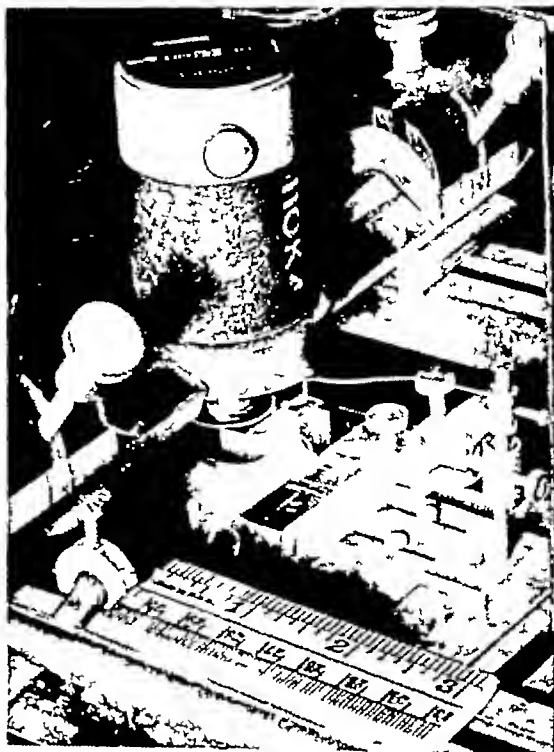


Fig. 2 Bone sectioning apparatus showing motor mounting and arrangement for clamping flexible plastic cover slip in contact with upper end of bone

heavy to ensure rigidity. In addition, the motor mounting must permit a small amount of rotation of the motor about a horizontal axis perpendicular to the direction of motion of the bone carriage. This must provide a very rigid but fine adjustment of the angle of attack of the saw blade, in order to eliminate any tendency on its part to cut out of or too deeply into the bone.

The bone to be sectioned was embedded in bioplastic. After this material solidified, it was trimmed by means of a hand grinding tool so as to leave a thin shell of bioplastic surrounding the bone. A portion of the bioplastic extending beyond the end of the bone was left in the form of a block to permit clamping in the movable carriage of the microtome. The carriage was then moved in the conventional manner, but much more slowly, so as to feed the bone to the saw. The speed of the saw was controlled by means of a variable transformer. The cut section was retained on the lower side of a plastic cover slip,

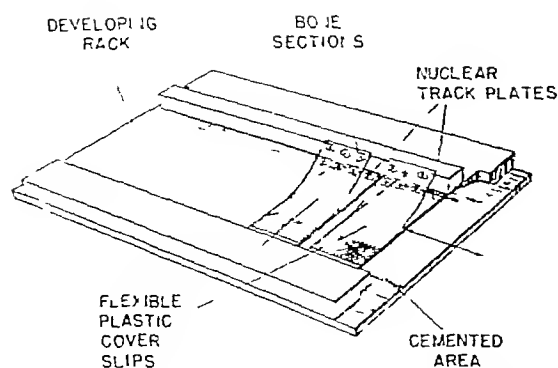


Fig 3 Detail of nuclear track plate developing rack made entirely of lucite.

one end of which was clamped to the microtome carriage in such a manner that the opposite end rested on the squared end of the bone which formed the upper side of the cut section.

Sections may be cut in this manner at the rate of at least one a minute. Serial sections may be cut along the full length of the bone, with the loss of only about 150 microns of bone between sections. These are of uniform thickness, which may be as little as 30 microns. Figure 6 is a photomicrogram of a typical bone section cut by this method.

(2) *Autoradiographic Method* The correlation of radium distribution in each bone section with the structural details of the matrix necessitated the development of a special autoradiographic technic, which permitted exact registry to be retained between the alpha-particle track image of the radium distribution and the alpha-particle sources in the bone section. This problem was greatly magnified by the necessity of removing the bone sections from the nuclear track plate after exposure to permit developing solutions to reach the emulsion under the section and to avoid immersing the section in the solutions. It was found desirable, also, to remove the bone section for photomicrographic purposes. It then had to be returned to *exactly* the position it occupied on the nuclear track plate during exposure.

These requirements were met by mounting six or eight bone sections at the end of one side of a transparent plastic cover

slip. The opposite end of this cover slip was then cemented to the emulsion side of a nuclear track plate with the bone sections in contact with the emulsion. The sections were pressed in intimate contact with the emulsion during exposure.

At the end of the exposure period, the nuclear track plate with attached cover slip was placed in a plastic developing rack, as shown in Figure 3. The end of the flexible cover slip to which the bone sections were attached was lifted away from the emulsion and held above the surface of the developing solutions by the rail until the development process was completed.

Following development, the bone sections and their respective autoradiograms were examined microscopically. Photomicrographs of interesting fields in the bone matrix and the associated alpha-particle tracks were made. The best photomicrographic results were obtained by lifting the end of the cover slip with attached bone sections away from the nuclear track and focusing the microscope directly on the alpha-particle tracks, as illustrated by Figure 4. The bone sections were then allowed to fall back to their original positions and the microscope was focused upon them.

Careful tests have been made to determine whether this method provides and maintains exact registry between the bone section and the alpha-particle image of the radium distribution. No evidence of slippage has been found.

RESULTS

While it has long been recognized that the radium distribution in the bone matrix is non-uniform, the variations to be expected in the volume density have not been known.

Possible understanding of the effects of radioactive substances deposited in bone depend upon knowledge of the manner in which the substance is deposited and of maximum volume densities to be found. This is true particularly as regards the mechanism by which bone sarcomas are

induced by radium. It has previously been assumed that the effects of radium in the body of an animal must necessarily be proportional to the total quantity fixed in the bones. This may be true as regards acute effects resulting in the development of anemia. It may not necessarily be true as regards the development of bone sarcomas usually associated with chronic radium poisoning.

Microscopic studies of alpha-particle autoradiograms in these experiments have

have been superimposed in registry as during the original exposure.

Examination of large numbers of bone sections and their autoradiograms appears to affirm an invariable association of areas of optical density with localized concentrations of radium in the bone. It cannot be definitely stated, at this time, that there is a metabolic relation between the darkened areas and the localized radium deposits. If there is such a relationship, however, it appears that the radium is con-

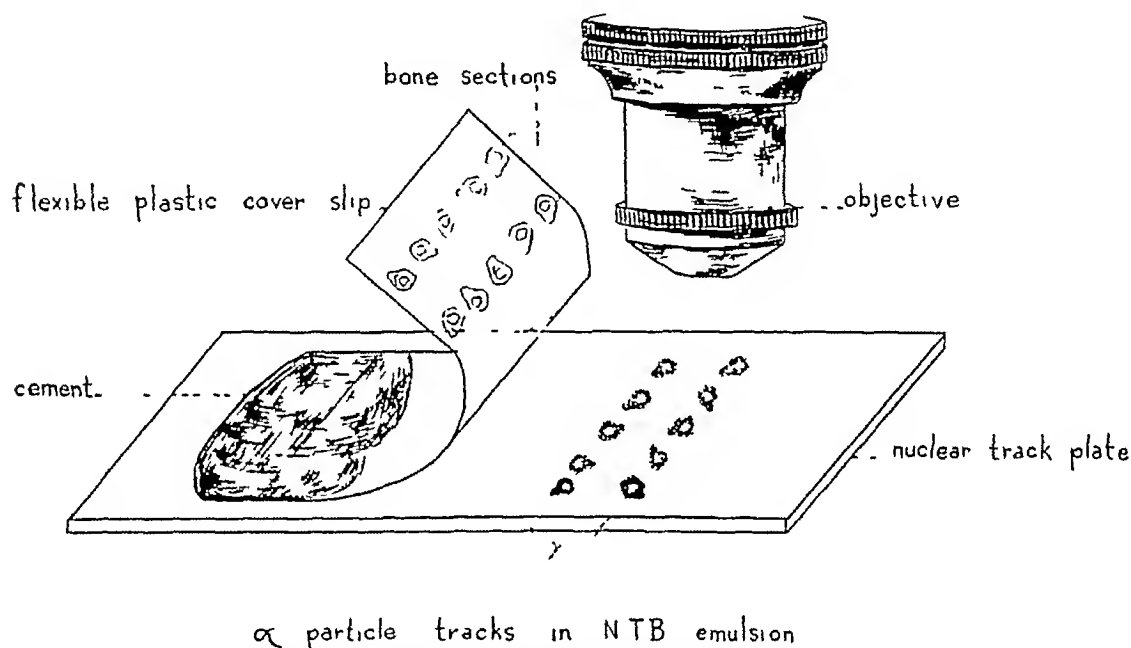


Fig 4 Method of studying alpha-particle tracks on the nuclear track plates. This technique eliminates the necessity of focusing through the reverse side of the slide and interference due to passage of light through the bone section.

disclosed minute localizations of radium at various points in the bone matrix and the periosteum which seem to bear no simple relationship to the total radium in the bones. One type of localization is illustrated by the alpha-particle autoradiogram of Figure 5. When this is compared with the photomicrogram of the bone section, reproduced in Figure 6, the high alpha-particle densities are observed to coincide with areas of increased optical density in the bone matrix. This coincidence may be more clearly shown by the composite photomicrogram of Figure 7, in which the autoradiogram and bone section

centrated in this manner because of the presence of these differentiated areas rather than the reverse. This conclusion is based on the observation of differentiated areas unaccompanied by heavy deposits of radium. The microscopic details of the optically dense regions do not show well in the photomicrogram, but careful study seems to disclose a higher density of canaliculi in these areas.

Concentrated deposition of radium is observed to be associated with another type of differentiation in the bone matrix. This is illustrated by the autoradiogram of Figure 8 and by the accompanying bone

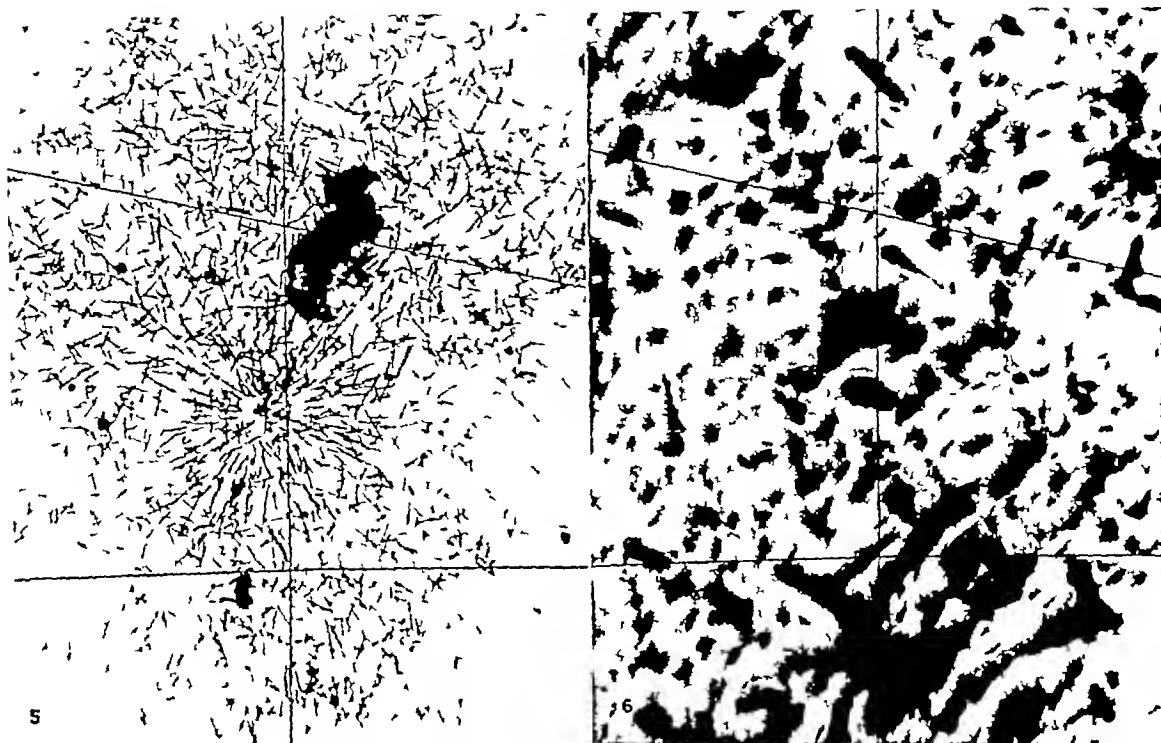
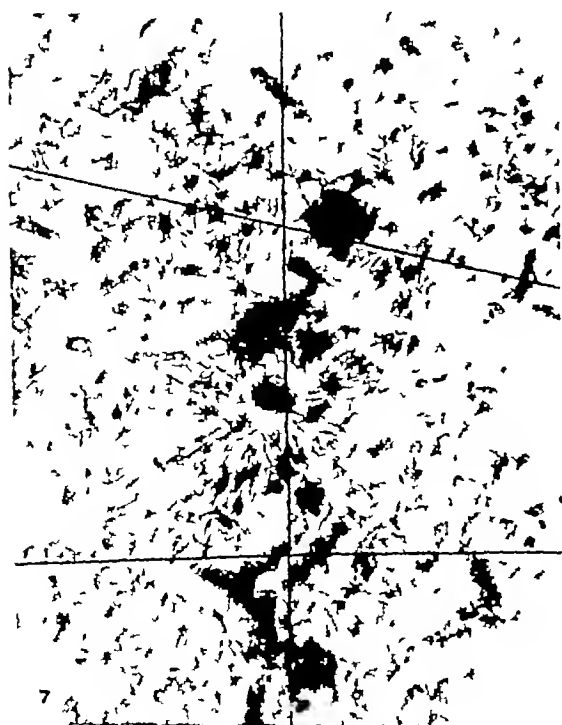


Fig 5 Photomicrograph of alpha-particle track autoradiogram resulting from the presence of radium in a thin section of a rat tibia. Exposure forty hours. The distance between points of intersection of horizontal lines with the vertical line is 180 microns.

Fig 6 Photomicrograph of the portion of the bone section of which Fig 5 is the autoradiogram. The rat from which this tibia was taken received 30 micrograms of radium chloride intraperitoneally at the age of twelve weeks and was sacrificed fourteen days after injection. Radium burden at death was 6.9 micrograms.



section, Figure 9. Here again a clearly defined differentiated line within the bone matrix is seen to be the site of heavy deposition of radium. In this case, however, the dense region in the bone appears to have resulted from the injection of the radium. The low-power photomicrograph of the bone section, Figure 10, shows a well defined line of high optical density which is approximately concentric with the marrow cavity. In this case, the radium had been injected when the rat was twelve weeks old, five months previous to the date of killing. The inner ring of seemingly normal matrix is believed to represent bone growth before the radium injection. The ring of differentiated bone is believed to have been laid down coincident with the deposition of the radium. This conclusion

Fig 7 Composite print of the negatives of Figs 5 and 6 superimposed in exact registry, as during the autoradiographic exposure.

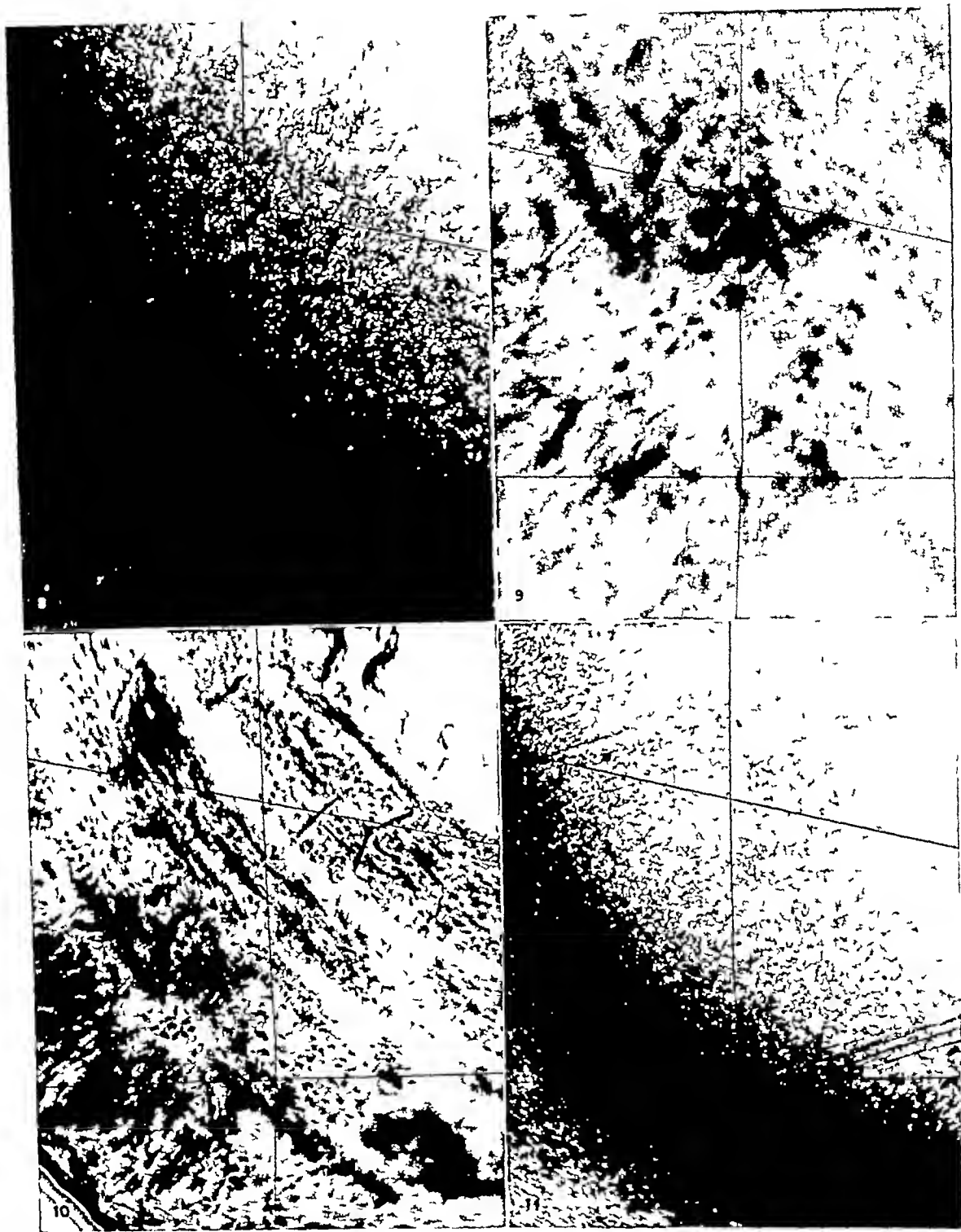


Fig 8 Photomicrogram of a portion of an autoradiogram of a section of rat tibia Exposure forty seven hours
 Fig 9 Photomicrogram of the portion of the bone section of which Fig 8 is the autoradiogram This rat received 40 micrograms of radium chloride injected intraperitoneally at the age of twelve weeks and was sacrificed five months after injection
 Fig 10 Low power photomicrogram of a portion of the bone section of which a part is shown in Fig 9
 Fig 11 Low power photomicrogram of the autoradiogram of the area of the bone section shown in Fig 10

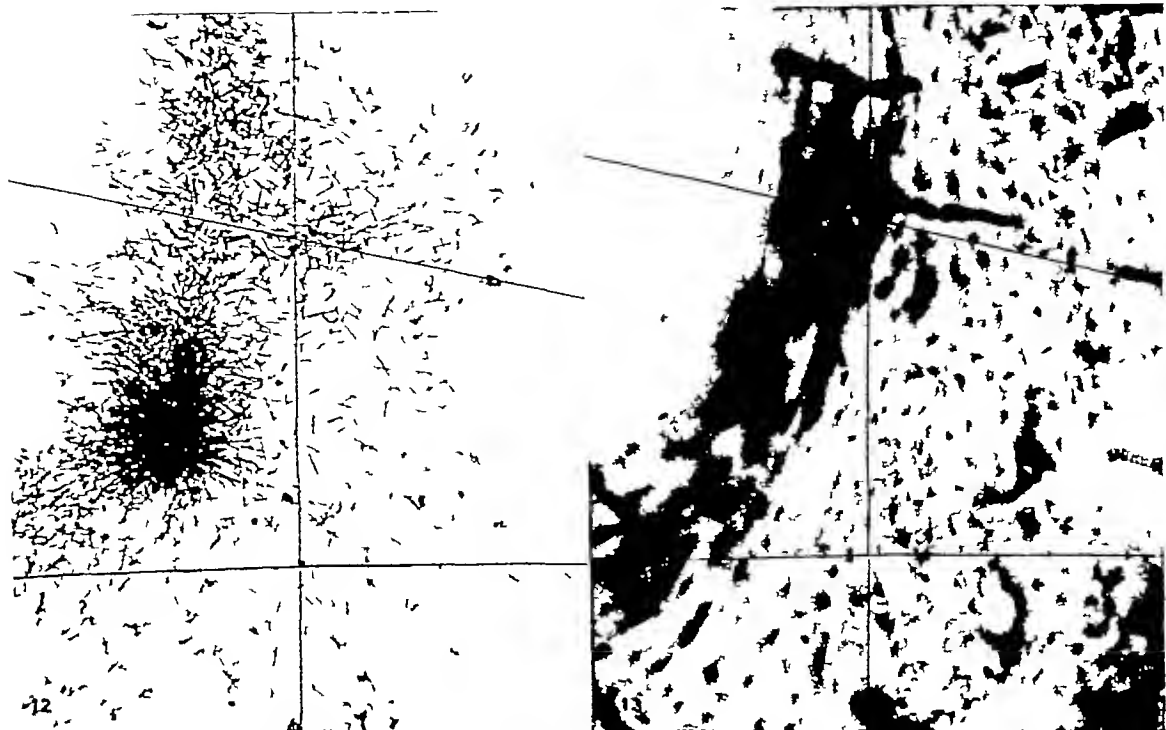


Fig 12 Photomicrogram of a portion of an autoradiogram of a section of rat tibia Exposure, forty hours

Fig 13 Photomicrogram of the portion of the section of rat tibia of which Fig 12 is the autoradiogram This animal received 30 micrograms of radium chloride at the age of twelve weeks and was sacrificed fourteen days after injection.

is based on the fact that the radium concentration, Figure 11, coincides *exactly* with this optically dense ring. Subsequent normal bone growth corresponds to the portion outside the dense ring.

Perhaps the most interesting localization is the type shown in Figure 12. The alpha-particle track pattern appears to emanate from a radioactive deposit in a region of very dense bone (Fig 13) confined to an extremely small volume, estimated at 5×10^5 cubic microns. The tissue in the immediate region of a radium localization of this type must, of course, receive a very heavy bombardment by alpha particles. The ionization produced in any given minute volume of tissue during a reasonably long period of time, say twenty-four hours, will depend upon its location with respect to the radium deposit. Microscopically, this deposit does not appear to be a point source. On the other hand, the autoradiogram indicates that, as the center is approached, the number of alpha particles per unit volume increases rapidly.

Consequently, it is extremely difficult to express the tissue dose due to alpha-particle bombardment in terms of roentgens or roentgen equivalents. The problem is complicated further by the high specific ionization due to alpha particles and the consequent greater biological effectiveness.

However, the average ion density may be estimated, and, when this is converted to roentgens on the basis of 1.62×10^{12} ion pairs per gram of tissue, some idea of the alpha-particle tissue dose may be obtained.

An estimate of the tissue dose due to the alpha particles has been made, as follows. A reduced (twelve-hour) autoradiographic exposure of this area was made. This resulted in an alpha-particle track density such that the tracks emanating radially from the localization area could easily be counted. An arbitrary circle of 25 microns radius was drawn about the center of the radium locus. Then all alpha-particle tracks which, when projected back toward the center, pass through this arbitrary

rary circle are considered to originate from radium deposited within a volume of which this circular area is the great circle

Since a means has not yet been devised for locating the saw cut with reference to the center of the deposit, it has been assumed, for purposes of this estimate, that the arbitrary circle coincides with the center of the deposit. Any error involved in this assumption tends to reduce the estimated dose. It is assumed further that the nuclear track plate has registered one-fourth of all the alpha particles emitted from the radium in this volume.

It seems reasonable that the maximum volume of bone in which these alpha particles would have expended their energies is a volume having as its radius the radius of the arbitrary circle plus the maximum range of an alpha particle in bone. This range is not known accurately but has been assumed to be 25 microns.

The total number of ion pairs produced by the alpha particles per gram of tissue has been calculated on the basis of the above assumptions. The approximate average tissue dose thus obtained for the radium locus of Figure 12 is 500 roentgens per twenty-four hours in the volume considered. It must, of course, be evident that many assumptions are involved in this estimate, which may have to be revised at a later date, but estimates made in other ways yield doses of nearly the same value.

Any tissue receiving such a dose would, of course, be killed. It seems, therefore, safe to assume that there will be a more or less spherical volume of tissue associated with this type of localized deposit which will be killed soon after the deposition of the radium. This volume of dead tissue would enlarge with time as the total cumulative dose at the boundary reached the lethal value. There will at all times be a surrounding volume of tissue which has received a sublethal dose, but which is subjected to continual bombardment.

A high incidence of osteogenic sarcoma has been repeatedly demonstrated in human victims of radium poisoning and in

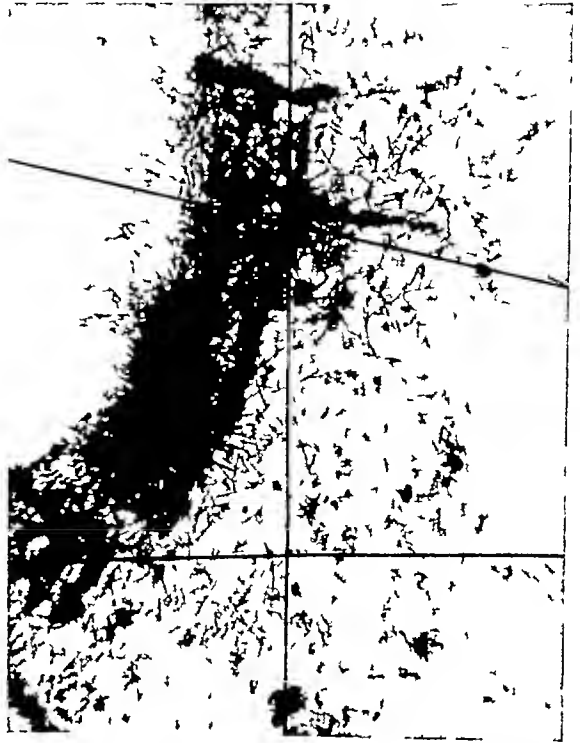


Fig 14 Composite print of the negatives of Figs 12 and 13 superimposed in exact registry, as during exposure

laboratory animals which have received radium by injection and otherwise. These sarcomas have been attributed to the presence of radium in the bones, although the precise manner in which the sarcomas might be induced has received little attention.

These studies have demonstrated the existence of microscopic localizations of radium deposited metabolically in the bones of rats. Consideration of the tissue dose due to alpha-particle bombardment and the resultant tissue reaction in the sublethal dose border region may offer a reasonable basis for a theory of the production of bone sarcomas in chronic radium poisoning. Further studies along this line are being intensively pursued.

NOTE This work has been sponsored by the Office of Naval Research under contract N6onr 260-T O -1

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SUMARIO

Diferencias Histológicas en la Matriz Ósea Asociada con el Radio Metabolizado

Los siguientes son los resultados preliminares de los estudios de la distribución del radio en ciertos huesos de ratas que contenían radio depositado metabólicamente. Después de inyectar cloruro de radio en suero fisiológico en las ratas, se determinó autorradiográficamente la distribución del radio en los huesos rastreando las partículas alfa en placas de trazos nucleares (NTB Eastman). La matriz ósea fué estudiada microscópica y microfotográficamente en busca de alteraciones histológicas y de zonas diferenciadas asociadas a los depósitos de radio. Para este fin se introdujo una técnica especial de cortes de huesos, así como una técnica autorradiográfica *ad hoc*, que permite retener la relación exacta entre la imagen de los rastros de partículas alfa del radio distribuido y los focos de partículas alfa en el corte óseo.

El examen de grandes cantidades de

cortes óseos y de sus autorradiografías pareció establecer una asociación invariable de zonas de densidad óptica con concentraciones localizadas de radio en el hueso. Por ahora, no cabe afirmar positivamente que exista relación metabólica entre las zonas oscurecidas y los depósitos de radio. Sin embargo, de existir dicha relación, parece que el radio se concentra en dicha forma debido a la presencia de dichas zonas diferenciadas, más bien que lo contrario.

Dedúcese que el estudio de la dosis histológica debida al bombardeo por partículas alfa y la consiguiente reacción histológica en la región colindante con la dosis subletal puede aportar una base lógica para una teoría de la producción de osteosarcomas en la intoxicación crónica con radio. Los estudios en este sentido prosiguen intensamente.

DISCUSSION

(Papers by Jacobson, Marks, and Lorenz, in March issue, p 371, Zirkle, Hoecker and Roofe)

Titus C Evans Ph D (Iowa City, Iowa) The report by Dr Jacobson is very interesting, but somewhat disturbing. The reasoning on which most radiotherapy is based is that rapidly multiplying immature cells are more radiosensitive than mature and mitotically inactive ones. It might be concluded from the data just presented that the above generalization is in error. I believe that we should keep an open mind until we decide whether these results indicate an exception to the general rule, a new phenomenon, a confusion of terminology, or an incomplete picture.

As regards terminology, it seems that we must decide whether radioresistance means that few cells are destroyed or that many cells survive. In Dr Jacobson's experiments the number of cells present during or soon after irradiation is increased by certain stimuli. About as many cells in the hyperplastic marrow survive a certain radiation exposure as survive in

bone marrow irradiated without the growth stimulus. However, more cells have been destroyed in the case of the hyperplastic marrow. Now, let us compare two cases of lymphoid leukemia. One patient has a white cell count of 200,000, which, after a relatively small dose, is reduced to say 8,000. This is a tremendous effect. In another patient, a blood count of let us say 18,000 is reduced by the amount of radiation to perhaps 4,000. The relative effect has been much greater in the case of the very hyperplastic leukemia, yet the appearance of the bone marrow in the latter case must have indicated that there were fewer residual cells.

If it turns out that experimental modification of cell number at the time of irradiation affects the percentage of cells surviving, then it would appear that the chief radiation effect was an indirect one. If, however, the effect is indirect, then a certain number of molecules of a toxic material would be produced, a

number of cells would be affected, and the percentage effect would depend on whether we had one or a hundred cells per molecule of the poison. Such indirect effects may be due to "activated water," hydrogen peroxide, or histamine-like substances.

A third possibility is that, under the additional stimulus, surviving cells are able to regenerate the bone marrow more rapidly than usual. There are many very interesting problems in connection with this study, and I am sure that Dr Jacobson will not stop at this point but will carry his experiments on even more extensively.

As to Dr Zirkle's paper, I feel that I should mention that we all recognize the important role played by his study of the effects of alpha particles. We have become aware of the effect of specific ionization, and those who used to argue about the effects of wave lengths have been brought to a better understanding of this subject because of this type of work.

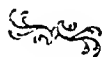
One is tempted in a study of effects on cells in a suspension, to attribute some importance to effects produced not on the cells themselves, but in the water molecules which indirectly affect the cells. The work is too detailed to go into at this time. The exposures required to demonstrate "activated water" are higher than the usual therapeutic range.

One of the poisons produced that can be identified is hydrogen peroxide, and we are interested in knowing if hydrogen peroxide could account for the entire biological effect. We have found that it does not. If we increase the exposure tremendously, we are able to produce enough hydrogen peroxide in the water to have, in turn, an effect on the cells that have themselves been unirradiated. Not only will the hydrogen peroxide eventually kill the cells, but it will affect cell division. Now, one of the main things that has kept our feet on the ground regarding hydrogen peroxide, I believe, is that we are all aware that there is an enzyme in the cells called catalase, whose apparent function is to destroy hydrogen peroxide. It is supposed that this is perhaps the only function of this enzyme in the cell metabolism. It is there to de-

stroy the hydrogen peroxide normally produced during the process of respiration, so that it will not be toxic. Therefore, in supposing that radiation might have a basic effect on cells in the production of hydrogen peroxide, one would have to assume that radiation would destroy the catalase. Some of us have attempted to learn something about this. We irradiated the catalase after it had been extracted from the cells and found that it was very radiosensitive in dilute solutions, as Dr Zirkle has indicated. It was more resistant in concentrated solutions. Addition of albumin, for example, would protect the enzyme even in dilute suspensions. However, if we irradiated the cells and then extracted the irradiated catalase, we found only a slight effect, and this effect was not increased with increase in dosage. As we increased the exposure time, we would increase the number of cells destroyed, as well as the delay in cleavage, so that these effects and that of catalase destruction were not at all parallel. We are at a loss to explain the effects, even though there are certain similarities. It must be that there is something more basic, that the general effect is one of oxidation, similar in a general way to the action of hydrogen peroxide.

This particular poison, however, is only one of many possible agents, and I might say in passing that we are very interested in the findings indicating that certain enzymes are very sensitive—these nucleic acid studies, etc. What worries me most is that most of these effects are temporary, while the effects that we see in the cells are continuous and are continually growing worse, from the standpoint of increasing entropy or loss of potential energy, so that eventually the cell seems to wear out.

I think Dr Hoecker has demonstrated that he has the technique which will give him the information that he is after, and I believe that it has already given some information on this subject. The dense areas which he describes are very interesting. It would be of value to know whether they represent affected areas or whether they exist normally and are regions with a particular affinity for radium.



Individualizing the Tumor Dose in Carcinoma of the Uterine Cervix by Means of a Simple Caliper¹

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IT IS THE PURPOSE of this paper to present a new instrument, a simple caliper, which is believed to offer an accurate, rapid, and convenient method of individualized treatment of carcinoma of the uterine cervix, based on actual tumor dose. This caliper permits direct skin-to-cervix measurement. While the method is admittedly less precise than some of the more elaborate techniques described in the literature, it does offer, especially to the busy radiologist with limited personnel and equipment, a procedure whereby the entire treatment plan in any individual case may be worked out in a matter of minutes.

The accompanying illustration (Fig 1) demonstrates the general features of the instrument. One rod—the vaginal piece—has a straight, free shaft which is calibrated linearly in centimeters from the tip. An obtuse angle (about 120 degrees) near the hub permits easier use for posterior measurements. The other rod is curved throughout its length to give clearance to the body parts. The centimeter calibration on the flat pieces is shown on both sides of the caliper for convenience.

The purpose of the centimeter scale on the straight rod is to obtain a measurement of the cephalad location of the cervix beneath the anterior abdominal wall in relation to the inferior margin of the pubic symphysis, establishing the cephalad-caudad position of the treatment field. This linear calibration is of no value for determining the cephalad-caudad location of the posterior treatment fields, since there is no bony landmark immediately posterior to the vagina to serve as a guide, and the bony contour in this region does not permit localization by this means. The posterior fields are measured to the center of the sacrosciatic notches.

The caliper is used in the following manner. The patient is prepared for pelvic examination in the usual position. The examiner introduces the straight rod into the vagina, guiding its tip to the cervical os (or lesion) with the fingers of one hand. While this tip is kept accurately in contact with the os during all measurements, the other hand swings the curved rod into position on the skin surface of the abdomen at the approximate center of the treatment fields to be used, and the operator reads the distance between the opened tips, which corresponds precisely to the thickness of the tissues traversed by the incident central beam of radiation in reaching the cervix.

The anterior measurements are made with the patient supine, preferably with the thighs not flexed, so that the anatomical relationship will correspond as nearly as possible to that which exists during treatment. The posterior measurements are best made with the patient prone, but, if the examining table in use does not allow a prone position suitable for the procedure, the patient can be turned to the left side for the right posterior and to the right side for the left posterior measurements. A direct lateral measurement can be made by having the patient flex the thighs so that the curved rod can be brought laterally in the horizontal plane of the cervix. After all of the desired measurements from the skin surface (at the center of the treatment fields) to the os have been obtained, standard depth dose tables are consulted, and a treatment plan based on actual tumor dose (cervix dose) is calculated in the manner described by Camiel and Blatz.

Since the measurements obtained correspond essentially to the "effective depth" as defined by Camiel and Blatz, their system of dosage calculation is employed to

¹ Accepted for publication in April 1948

determine the number of treatments needed for each field in order to obtain a pre-determined tumor dose. Depth dose tables readily indicate the "effective dose" per 100 r in air at each field. The desired tumor dose is then divided by the sum of the "effective doses" to find the number of treatments needed for each field.

For example, let us suppose the following

given to each field, then the effective dose at this rate is 348 r ($174 \text{ r} \times 2$). Let N be the number of treatments needed for each field when a total tumor dose of 4,000 r is desired and we see that

$$N = \frac{\text{desired tumor dose}}{\text{sum of effective doses}} = \frac{4,000 \text{ r}}{348 \text{ r}} = 11.5 \text{ treatments}$$

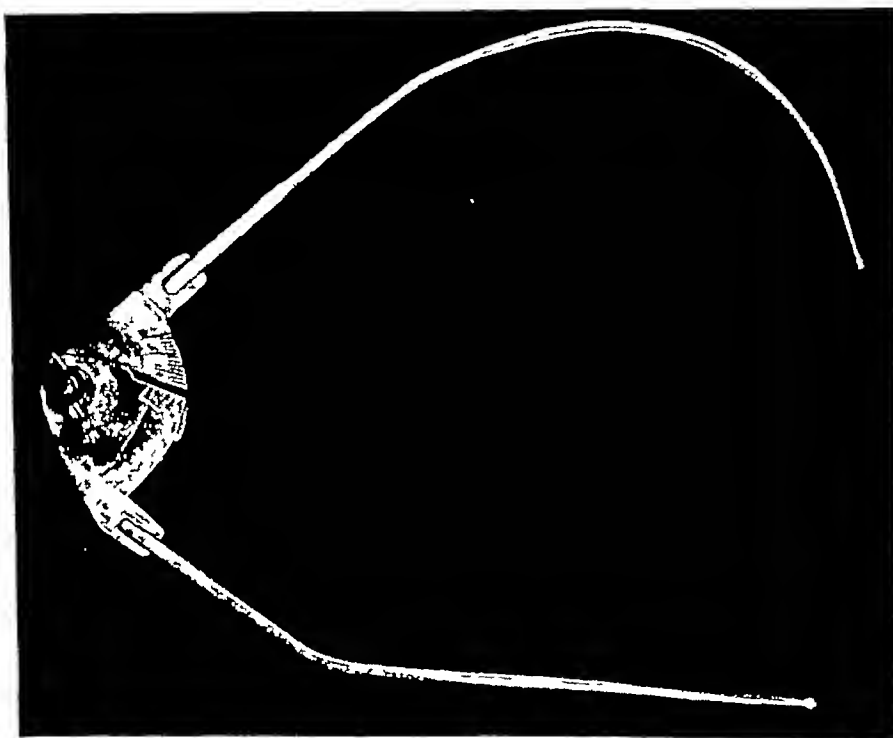


Fig 1 Showing the essential features of the caliper. The straight (vaginal) rod is calibrated in centimeters along its inner surface. Each of the calibration lines on the flat piece indicates one centimeter, each five centimeters are emphasized by longer lines and figures.

measurements were obtained: two anterior oblique fields 13 cm, two posterior oblique fields 15 cm, two direct lateral fields 15 cm. The effective dose per 100 r in air is 33 r for the anterior oblique, 27 r for the posterior oblique, and 27 r for the direct lateral fields, at 200 kVp, with 0.5 mm Cu plus 1.0 mm Al filtration, 50 cm target-skin distance, and 10×15 -cm fields.² The sum of the effective doses for a single cycle is 174 r ($33 \text{ r} \times 2$ plus $27 \text{ r} \times 4$). If 200 r in air are to be

Twelve treatments would give a tumor dose of 4,176 r.

With this method of determining the cervix depth from the center of oblique treatment fields, it is not at all uncommon to find the measurements to be in excess of 10 cm. So slight a thickness has been encountered only in the small, frail patient. It is likely, therefore, that most patients should be treated through more than four fields and that those having measurements in excess of 13 cm should be given air doses of more than 200 r per treatment in order to complete the series.

² Depth dose for 10×15 cm field obtained by interpolation.

in approximately four weeks. The higher skin doses probably can be tolerated well, since the greater number of fields will permit a longer recovery period between treatments administered to the same field. It is also likely that those patients having measurements greater than 15 cm should have the external irradiation divided into two courses at intervals of two to three months, with intracavity radium application during the rest period.

It is realized that external irradiation is only one of the radiologist's methods of treatment, and that, especially in patients of great thickness, the other technics (radium and transvaginal roentgen therapy) must be utilized in a coordinated manner in order to reach the goal of a full, cancerocidal dose to the primary lesion and its advancing extensions. It is hoped that this caliper may

play a part in the evolution of an irradiation attack whereby there may be delivered to every neoplastic cell in the cervix, pelvic ligaments, and regional lymph channels a lethal injury without exceeding the tolerance limit of the patient.

It is possible that a similar caliper on a smaller scale might be useful in determination of the depth dose in other accessible orifices, such as the mouth.

SUMMARY

A simple caliper is described for assistance in accurate, individualized determination of the actual tumor dose in carcinoma of the cervix.

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SUMARIO

La Individualización de la Dosis Tumor en el Carcinoma del Cuello Uterino por Medio de un Sencillo Compás

El sencillo compás aquí descrito ayuda a individualizar la dosis tumor en la irradiación externa por carcinoma del cuello uterino. Introducida una rama del compás en la vagina y mantenido el extremo en contacto con la boca cervical (o la lesión), la otra, encorvada adecuadamente (véase el grabado), es girada a su posición en la cara del abdomen en el centro aproximado de los campos predeterminados para tra-

tamiento. Luego se lee en una escala calibrada la distancia entre las dos puntas del compás, correspondiendo la misma al espesor de los tejidos que tiene que atravesar el haz de rayos X para alcanzar el cuello.

Después de determinar las mediciones deseadas de los varios campos, se consultan tablas guías para la dosis y la profundidad y puede trazarse un plan terapéutico basado en la real dosis tumor.

Effects of Continuous Radiation on Chick Embryos and Developing Chicks¹

II Bone Marrow, Lymphoid Tissue, and Peripheral Blood

SHIELDS WARREN, M D, and FRANK J DIXON, M D

THE FOLLOWING description of the effects of lethal and sublethal continuous radiation on the bone marrow, lymphoid tissue, and blood of chick embryos and developing chicks, by means of the isotope P^{32} , is the second part of a study embracing all the tissues in these subjects and including measurements of the localization of the agent within the tissues (2)

The findings described in the first report were briefly as follows

Radiation caused an over-all growth retardation resulting in small but well proportioned birds

Both testes and ovaries were very radiosensitive, the primitive germ cells being the most sensitive element. The spermatogenic cells of the testes remained extremely sensitive to radiation throughout their development, while the ova became more radioresistant as they matured

Bone growth was retarded by radiation. The cartilage cells of the epiphyses were much more radiosensitive than the osteoblasts and osteoclasts. After irradiation ceased, the histologic changes were reversible and the bones regained a normal histologic structure but remained dwarfed

MATERIALS AND METHODS

P^{32} combined as KH_2PO_4 was injected into eggs which were incubated under the usual conditions of 38-39° C and 70-80 per cent relative humidity. The incubated eggs were divided into groups according to the amount and time of injection. Injections varied in amount from 47.5 μc to 300 μc . At regular intervals embryos and birds were selected at random from

each group, killed by decapitation, and studied histologically

In order to study radiation effects later in the course of development, subcutaneous injections of approximately isotonic solution of P^{32} as KH_2PO_4 were made into twenty-four chicks after hatching. Doses varied from those producing no histologically demonstrable effects to those causing death. The smallest dose was 115 μc , the largest 3,696 μc

EFFECT OF RADIATION ON BONE MARROW²

Radiation had its crucial effect on the blood-forming tissues. The concentration of the radioactive substance within the bones caused heavier irradiation of bone marrow than of other tissues

Hematopoiesis takes place during the early part of incubation, largely in the blood islands of the vitelline sac. Between the tenth and twelfth day of incubation, the bone marrow begins its hematopoietic function, and several days before hatching it is the chief source of red blood cells and granulocytes. Blood-forming marrow develops in all bones, but the greatest number of hematopoietic cells is found in the long bones and vertebral bodies. The liver and spleen do not appear to be of importance in hematopoiesis in the embryo or young chick

Erythrocytes form within endothelial-lined sinuses of the bone marrow, apparently in communication with the circulation, and enter the circulation when they are mature. Granulocytes are formed in the intersinusoidal spaces and after reaching maturity migrate into the circulation

Hemocytoblasts, apparently the stem

¹ This work was done under Government Contract N5-ori 76 in the Laboratory of Pathology of the Harvard Cancer Commission. P^{32} supplied by Oak Ridge National Laboratories. Accepted for publication in May 1948

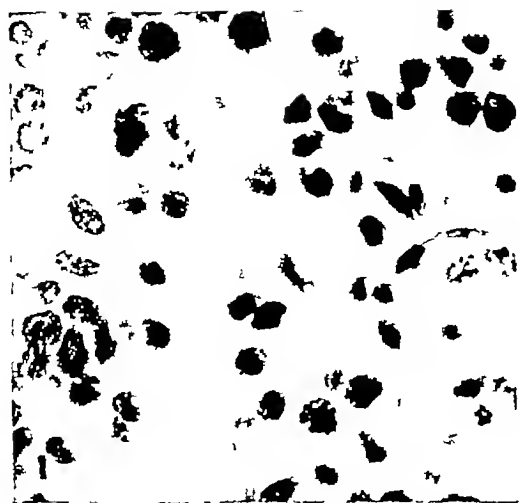


Fig 1 Femoral marrow from eighteen-day embryo given 120 μ c on fourth day of incubation. Marked depletion of marrow with increase in proportion of undifferentiated immature cells without signs of regeneration. Cells are irregularly scattered rather than in close packed islands as in normal (Fig 3) $\times 800$

cells of both granulocytes and erythrocytes, are found in the marrow, but most of the mature cells are formed by multiplication of early forms which have already partially differentiated and are fixed in their line of development.

The range of normal counts determined from our control birds during their first two months of life is given on Graph I. The oval, nucleated, mature erythrocytes of the chick measure approximately $12.2 \mu \times 7.3 \mu$ and contain hemoglobin in their cytoplasm. There are heterophilic, eosinophilic, and basophilic granulocytes which correspond roughly in appearance and relative frequency to their human analogues. Lymphocytes resemble human lymphocytes and are the most numerous of the leukocytes.

Study of the platelets and the altered clotting mechanism of the blood of these irradiated chicks will be the subject of a subsequent report.

Ectopic hematopoiesis did not occur in any of our birds, even though many of them had marked pancytopenia and no myeloid hematopoiesis. There were no infectious processes seen in chicks with prolonged agranulocytosis and lymphopenia, such as commonly accompany simi-

lar blood pictures in mammals. There were numerous petechial hemorrhages on the serous surfaces and in the muscles and lymphoid tissues of the most anemic birds, and some pulmonary edema, but these findings were almost terminal.

Our observation covered a period of continued growth of the hematopoietic tissue. Routine bone-marrow samples were obtained from the tibia and femur, a cervical, a thoracic, and a lumbar vertebra, and the skull.

Sublethal continuous irradiation of embryos had two effects on the bone marrow: first, proper maturation of the immature hematopoietic cells was inhibited; second, mitotic activity was reduced. The effects on the granulocytic and red cell series were not consistently different.

In the embryos given 100 μ c on the eighth or fourteenth day of incubation and those given 120 μ c on the fourth day of incubation, the above effects were clearly seen and were most obvious in well calcified areas where the radiation was heaviest. An increase in the proportion of immature forms, especially in the red cell series, resulting from reduced maturation, was first evident within four days, reached a maximum in one week, and remained a striking feature of the marrow for several weeks. During the first several days of irradiation, these immature cells showed no evidence of injury and displayed some mitotic activity, but as radiation injury became more severe, the mitotic activity was greatly reduced, the number of marrow cells decreased, and the proportion of stem and blast forms increased. These cells did not appear able to develop into mature blood cells. In the period of most severe radiation injury, one to two weeks after injection, the marrow contained one-fourth to one-third the normal number of cells. Most of these were immature forms and many were deeply basophilic, irregular in size and shape, showing no mitoses (Fig 1). Even at this time, however, the reticulo-endothelial cells appeared to be uninjured. Then, two to three weeks after injection, with

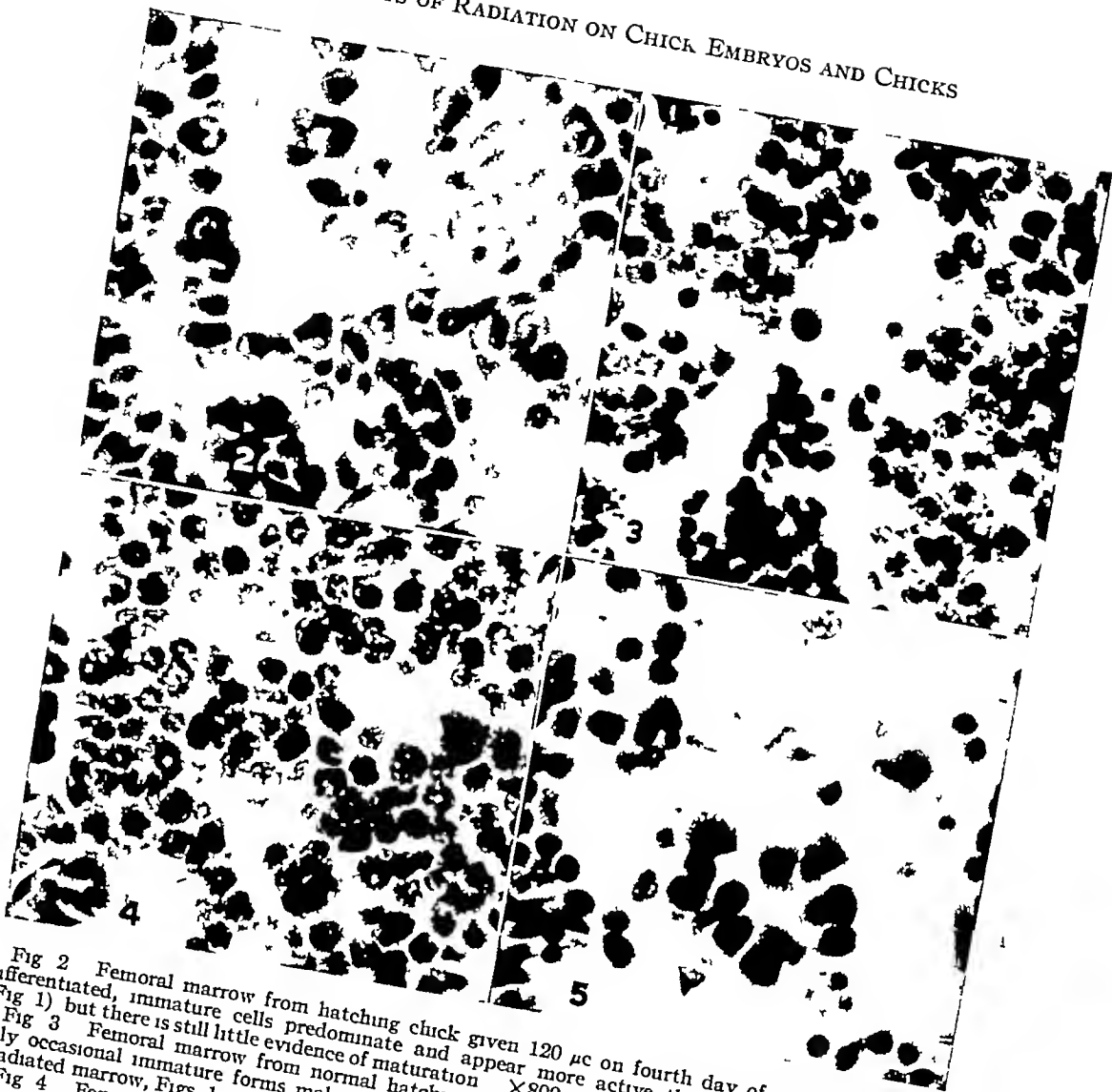


Fig 2 Femoral marrow from hatching chick given 120 μ c on fourth day of incubation. Undifferentiated, immature cells predominate and appear more active than three days previously (Fig 1) but there is still little evidence of maturation $\times 800$

Fig 3 Femoral marrow from normal hatching chick. Close packed differentiating cells with only occasional immature forms make up the cords and islands of the marrow (Compare with irradiated marrow, Figs 1 and 2) $\times 800$

Fig 4 Femoral marrow from normal seven-day chick. Note close packing of cells, most of which are partially differentiated granulocytes. The reticulo-endothelial and stem cells are not apparent $\times 800$

Fig 5 Femoral marrow from seven-day chick given 100 μ c on fourteenth day of incubation. Active regeneration is evidenced by many large stem and blast forms, large reticulo-endothelial cells and few irregular large, basophilic cells. Most of the cells are still very immature. Compare with normal seven-day marrow (Fig 4), where very few of these early forms can be seen $\times 800$

disappearance of radiation, the marrow began to recover (Fig 2) as the remaining immature cells first began to display mitotic activity and, several days later, maturation which resulted in the formation of normal adult cells. The reticulo-endothelial cells were larger than normal (Fig 5) and in a few instances appeared to be differentiating into hematocytoblasts, an occurrence rarely if ever seen in normal hematopoiesis. Complete recovery of

hematopoietic tissue followed, suggesting that no latent effects of radiation injury were operating in the first two months following irradiation. After recovery, these marrow showed occasional foci of small undifferentiated lymphoid cells, which were only rarely seen in unirradiated material. There was no regenerative hyperplasia of the marrow during our two to three month observation period following irradiation. The effect of lethal amounts of constant



Fig 6 Femoral marrow near lower epiphyseal line of normal seven-day chick. Marrow is well filled with close packed, hematopoietic cells $\times 200$

radiation (180 and 200 μ c) on the embryonic bone marrow was significantly different from the effect of sublethal doses. Instead of a temporary inhibition of maturation and mitoses which resulted from the smaller doses, the larger doses promptly halted mitotic activity and maturation, as seen two to three days after injection. As the marrow cells were lost, they were not replaced, and after about one week of radiation, the number of marrow cells was reduced to one-third normal, but there was no increase in the proportion of immature forms, as seen with smaller doses. Many of the immature cells of both series were deeply basophilic, small, and irregular in shape. The reticulo-endothelial cells did not appear injured. After two weeks of irradiation, the marrow showed maximum injury (Fig 7). Only a few hematopoietic cells remained, and they were basophilic, irregular and immature, but the reticulo-endothelial cells were still unchanged. The fat cells had undergone serous degeneration, with division of intercellular fat into numerous small droplets and the appearance of acidophilic granular protoplasm.

After two weeks, the level of residual radiation had apparently fallen below the point of suppression of mitosis and maturation

and there were early signs of regeneration on the part of both the few remaining immature hematopoietic cells and the reticulo-endothelial cells (Figs 8-10). There were scattered islands of stem and blast forms, which apparently had arisen from residual hematopoietic cells and were multiplying and undergoing some differentiation, although many of the cells of the red series were microcytic. The reticulo-endothelial cells were prominent and in several instances apparently gave rise to hematopoietic stem cells. This regeneration continued but was insufficient to prevent the development of a fatal pancytopenia several days later.

Discussion The extent of the effect of radiation on the bone marrow depended on the amount given. Yet, regardless of the size of the dose, the same two basic effects were seen: first, inhibition of normal maturation, second, depression of mitotic activity. These two factors merely varied in degree in the different series of chicks previously described.

That these effects were only temporary, since apparently normal maturation and mitoses could be resumed after irradiation ceased, was well shown in these chicks. The sublethal radiation injuries of the marrow appeared to be completely reversible. Even the birds in which fatal anemia developed showed some regeneration on the part of the few remaining hematopoietic and reticulo-endothelial cells shortly before death, after radiation had decreased. This hematopoiesis, however, was not sufficient to maintain a blood count compatible with life.

The determining factor in recovery of the hematopoietic function after irradiation appeared to be the number of hematopoietic cells which escaped fatal radiation injury. Even though these cells may have appeared distinctly abnormal during the height of the radiation injury, at least some of those that remained seemed to resume normal appearance and function once radiation ceased. Also worthy of emphasis is the formation of hematopoietic cells from the reticulo-endothelial cells,

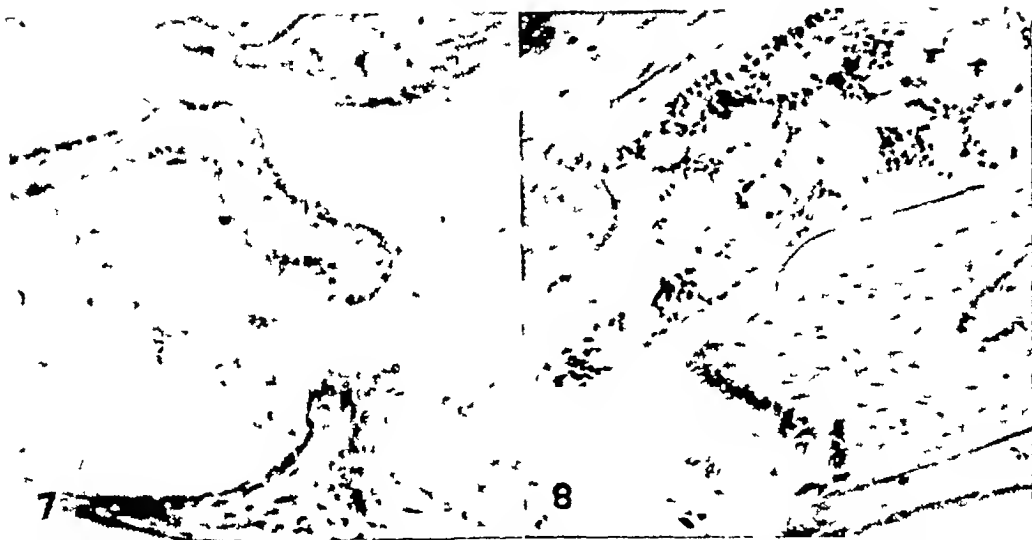


Fig 7 Section near lower femoral epiphysis of seven-day-old chick given $200 \mu\text{c}$ on the fourteenth day of incubation. Almost no hematopoietic cells are present. Fat shows serous change. Compare with normal shown in Fig 6. $\times 200$

Fig 8 Section near lower femoral epiphysis of eleven-day chick given $200 \mu\text{c}$ on fourteenth day of incubation. Early regeneration is evidenced by formation of small islands of hematopoietic cells. Compare with empty marrow of bird from same group examined four days earlier (Fig 7). High-power view of these regenerating islands given in Fig 10. $\times 200$

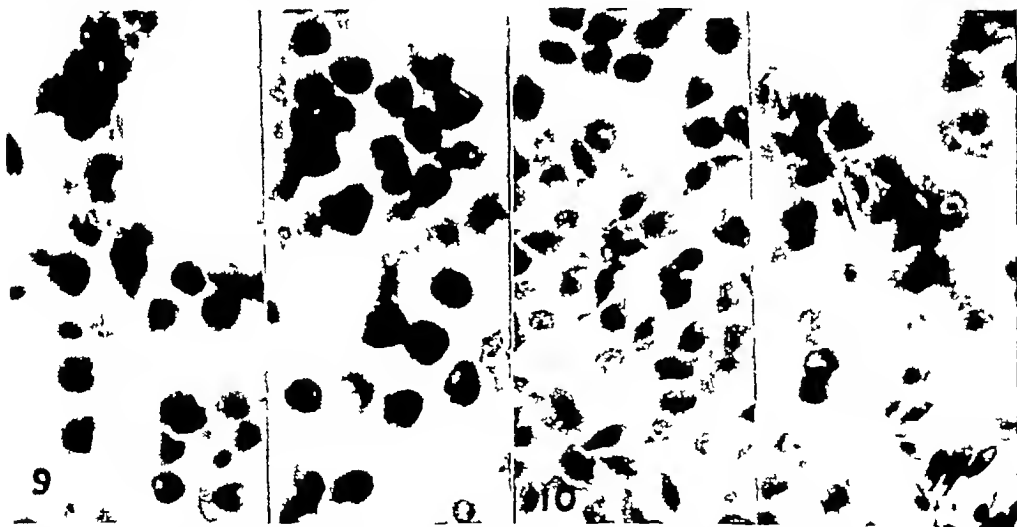


Fig 9 Femoral marrow near lower epiphyseal line of nine-day chick given $200 \mu\text{c}$ on fourteenth day of incubation. Two islands of regenerating stem and blast forms show very slight maturation. Note mitotic figure near the lower part of the picture. $\times 800$

Fig 10 Femoral marrow near lower epiphyseal line of eleven-day chick given $200 \mu\text{c}$ on fourteenth day of incubation. Regenerating islands are larger than two days previously (Fig 9). Some maturing cells (left) illustrate maturation, the second step in the marrow regeneration. Lower magnification of this marrow is shown in Fig 8. (Compare with normal marrow of seven-day chick in Fig 4). $\times 800$

which seemed to suffer relatively little from the radiation.

With regard to the problem of re-established hematopoiesis after radiation injury, it follows that, after radiation of the marrow has ceased, the injured hemato-

poietic tissue, composed mainly of a relatively unchanged reticulo-endothelial stroma and a few remaining hematopoietic cells, is still fertile ground for hematopoietic activity. This is evident from the resumed activity on the part of the residual

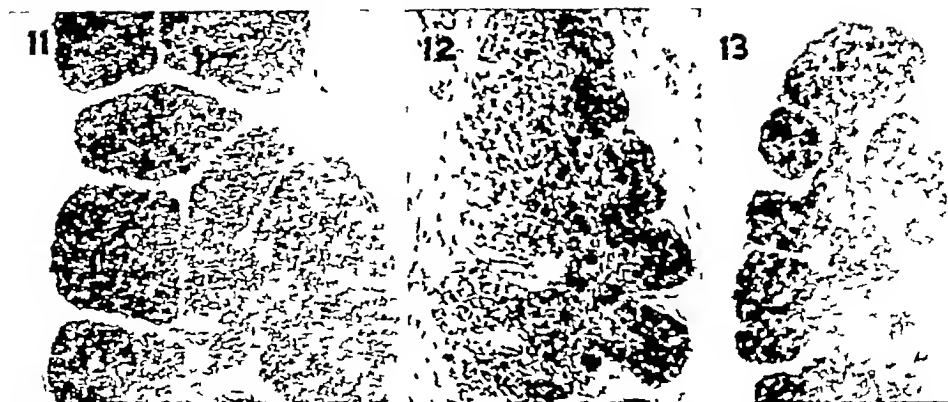


Fig 11 Thymus from normal thirteen-day embryo. Note large lobules well filled with lymphocytes. The medulla can be seen near the bottom of the picture. $\times 100$

Fig 12 Thymus from thirteen-day embryo given $120 \mu c$ on fourth day of incubation. It is smaller with fewer lymphocytes than normal. On the left, the fibroreticular stroma can be discerned but it is almost devoid of lymphocytes. $\times 100$

Fig 13 Thymus from fifteen-day embryo given $180 \mu c$ on fourth day of incubation. It is much smaller than normal thirteen-day embryo thymus and does not show the usual cortical medullary division. $\times 100$

hematopoietic cells. It is obvious that the marrow stimulants would be of very limited value in the almost complete absence of hematopoietic cells. Transfusion would be effective, but only temporarily, as a measure for a large number of cases, it is impractical. If feasible, the development of a method of replenishing the diminished marrow cells would afford a rational approach to the treatment of such injuries.

EFFECT OF RADIATION ON LYMPHOID TISSUE

The circulating lymphocytes arise largely in the thymus, spleen, cecum, and tonsils. Since lymphopoiesis is the same in all locations, we will limit our discussion to the thymus. The thymus consists of two paired chains of nodules extending through the whole length of the neck and lying adjacent to the carotid sheaths for most of their course.

About the twelfth day of incubation, when the blood islands of the yolk sac begin to degenerate and the bone marrow takes on the function of hematopoiesis, the primitive epithelial anlage of the thymus becomes lymphoid in character and shows much mitotic activity. This change in the character of the thymus appeared to be an *in situ* differentiation of the epithelial cells rather than a result

of infiltration of lymphoid cells from the outside. From the twelfth to the sixteenth day, a high mitotic rate in the lymphocytes continues and the thymus attains its definitive structure. It is histologically very similar to human thymus—*i.e.*, a cortex densely packed with small and medium lymphocytes in an inconspicuous reticular stroma and a medulla composed of a reticulo-endothelial stroma in which are found Hassall's corpuscles and a thin scattering of lymphoid cells. The thymus retains this structure and continues to grow during the first two months of life.

The injection of $100 \mu c$ into fourteen-day-old embryos caused an almost immediate complete cessation of mitosis, followed in two to three weeks by excessive proliferation of lymphocytes. Suppression of mitosis was noted two to four days after injection, when there was an average of one mitosis per oil-immersion field as compared to twelve to fifteen mitoses in the normal thymus of the same age. At this time, the number of lymphocytes was obviously diminished and the bulk of the organ had decreased to three-fourths of its normal size. But five days after injection the mitotic counts were a third instead of a twelfth of the normal, and a day later, *i.e.*, six days after injection, mitoses had increased to half the normal,

although the loss of lymphocytes in the cortex was still evident (Fig 16) A reactive over-compensation was apparent eighteen to twenty-two days after injection, when the mitotic count was four times higher than normal

As would be expected, 200 μ c on the fourteenth day of incubation produced a more severe and prolonged injury A practically complete cessation of mitosis, together with destruction of many lymphocytes, occurred in two to four days as with the smaller dose, but the response to this injury was delayed and there was a lapse of four to six days rather than one to three days before mitosis returned to half the normal and the depleted structure began to fill in with immature lymphocytes The response to injury, as evidenced by excessive mitotic division in the lymphoid cells, was similar to that noted with the smaller dose Mitotic counts were five times the normal values, sixteen, eighteen, and twenty days after injection By this time the thymus had recovered to virtually normal structure, but there were still agranulocytosis and a near-fatal anemia, and the bone marrow was only beginning to show regeneration

The same sequence of changes was noted when 120 μ c was administered to an embryo four days old Nine days later the thymus was half the normal size, only partly filled with lymphocytes, and entirely devoid of mitoses (Fig 12) Some evidence of recovery was noted three to five days later, on the eleventh and fourteenth days after injection, with a rise in the mitotic count to half the normal and a majority of large and immature lymphocytes Histologically, recovery was complete nine days after the appearance of the most severe injury and eighteen days after injection The thymus was still small, however, but in a seven-week-old bird there was no evidence that the gland had been injured

A prolonged retardation of growth of the thymus was noted after injection of 180 μ c on the fourth day of incubation Nine days after injection the thymus was one-



Fig 14 Thymus from normal nine-day embryo (one day before hatching) Note thick cortex well packed with lymphocytes $\times 50$

half normal size and closely resembled that of an embryo two or three days younger, except for decreased mitotic activity Eleven days after injection, the thymus was still one-half normal size but showed a normal mitotic rate (Fig 13) There seemed to be an inhibition of formation of the usual cortico-medullary structure The thymus was composed mainly of a reticulo-endothelial stroma and large, immature lymphoid cells, with only a few mature lymphocytes Seventeen days after injection, the cortico-medullary structure was present and mitotic activity was normal, but the thymus was two-thirds normal size Two hundred μ c on the eighth day of incubation had a more marked inhibitory action but the effect was otherwise similar Twelve days later, the thymus was one-third normal size, the cortex was poorly developed, and little mitotic activity was present (Fig 15) Twenty-seven days after injection, the then fifteen-day-old chicks were moribund from extreme anemia, but mitotic activity was at a normal level in the thymus, although the organ was still small and presented

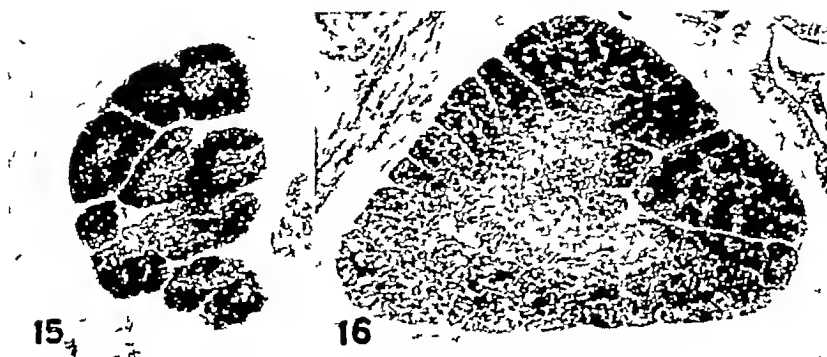


Fig 15 Thymus from one-day chick given 200 μ c on eighth day of incubation. It is markedly hypoplastic and shows no cortical medullary division. $\times 50$

Fig 16 Thymus from hatching chick given 100 μ c on fourteenth day of incubation. It is smaller than control in Fig 14 and its cortex shows loss of lymphocytes. $\times 50$

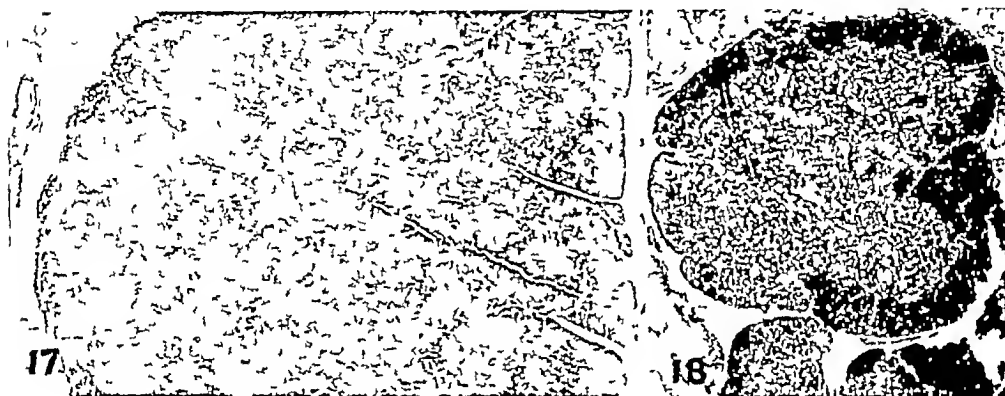


Fig 17 Section through thymus of normal fifteen-day chick. Cortico medullary structure is well formed and cortex is densely packed with lymphocytes. $\times 40$

Fig 18 Thymus from fifteen-day chick given 200 μ c on eighth day of incubation. It is markedly hypoplastic. Cortex is poorly developed and in some places absent entirely. Because of the small size of the thymus the Hassall's corpuscles are closer together than normal and give the impression of relative increase. $\times 40$

numerous cortical hemorrhages (Fig 18)

Injection of chicks produced an injury and recovery similar to that found in irradiated embryos, the injury being proportional to the amount of radiation. The fatal and near-fatal doses produce changes identical to those seen in the moribund fifteen-day chicks given 200 μ c on the eighth day of incubation.

Discussion In summarizing the effects on the lymphoid tissue in the thymus, there are several things that stand out. First, the high degree of sensitivity to radiation of the lymphocytes is shown by the marked suppression of mitotic activity and in appreciable thinning out of the cells two to four days after injection.

This occurred even with the smallest dose of 100 μ c. Only the gonads showed as early a response as this.

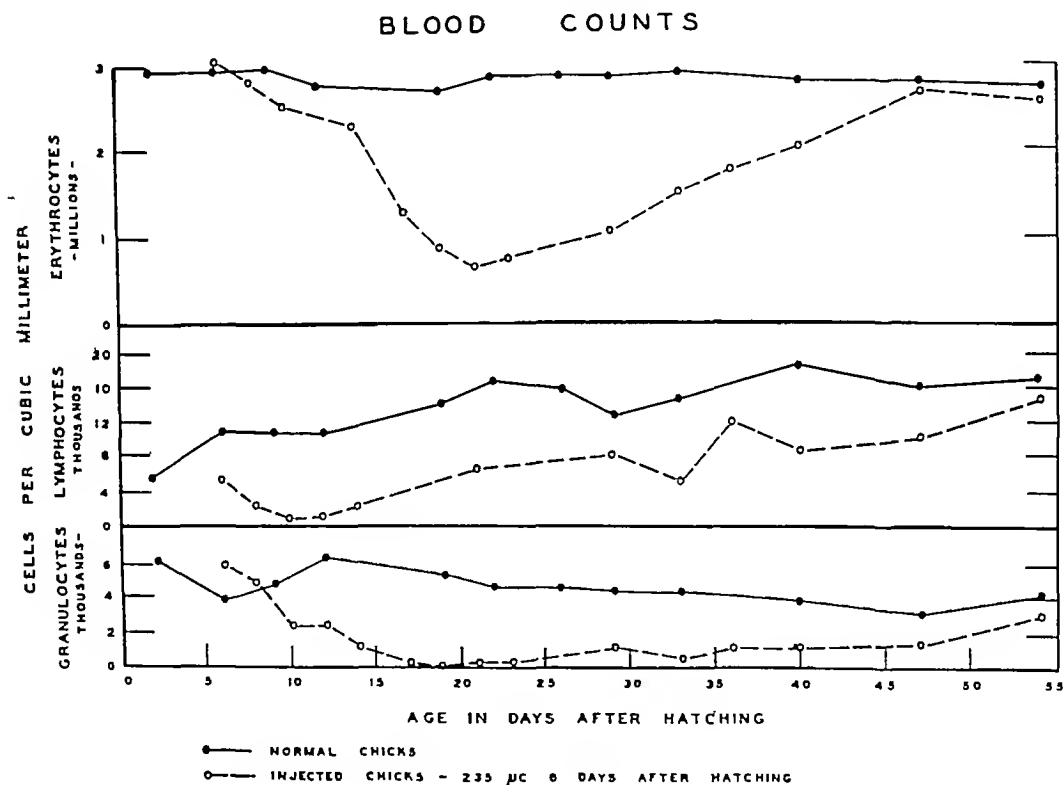
Second, regeneration of lymphoid tissue was rapid and started soon after injury. Except when large doses were given to young embryos, recovery was complete even in animals dying from anemia. Recovery was initiated from two to six days after the most severe depression of mitotic activity and was complete usually in less than three weeks. The histologic recovery of the thymus was more rapid than the recovery of the circulating lymphocyte count. The excellent recovery was no doubt due to the short duration of the injury. This was greatest during the

first few days after injection, before there was any appreciable concentration in the bone and the P^{32} was more or less uniformly distributed through the embryo

Third, the response to the injury was not only prompt and adequate, but was excessive. Long after the thymus had returned to a normal histologic condition the mitotic activity remained abnormally high. This may be related to the compensating hyperplasia seen in some animal tissues following irradiation.

The averages of the blood counts of these groups of birds are given on Graphs I, II, and III as absolute counts of red cells, granulocytes, and lymphocytes per cubic millimeter. Values obtained from the control birds are also given on each graph.

Blood cells in circulation are relatively resistant to radiation (1). The course of blood counts during and after irradiation is largely determined, therefore, by two factors: first, the degree of injury to the immature and developing cells of the hem-



Graph I

EFFECT OF RADIATION ON PERIPHERAL BLOOD COUNTS

To establish the changes in the peripheral blood counts during and following irradiation, we subcutaneously injected chicks of three different age groups with P^{32} and compared the blood counts with counts obtained from ten control chicks raised under the same conditions. Four six-day chicks were injected with 235 μ c, 4 nineteen-day chicks with 300 μ c, and 3 twenty-eight day chicks with 760 μ c

atopoietic system, and second, the length of life of the circulating cells. The previously described changes in the bone marrow of irradiated embryos and chicks showed that there was no great difference in the radiosensitivity between the granulocyte series and erythrocyte series. The lymphoid tissues, on the other hand, showed earlier injury and more rapid recovery than did bone marrow, partly because of the concentration of P^{32} in the bones, which permitted only a relatively

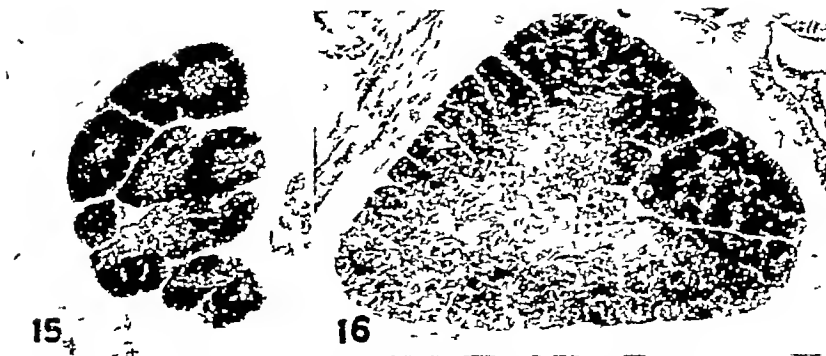


Fig 15 Thymus from one-day chick given 200 μ c on eighth day of incubation It is markedly hypoplastic and shows no cortical medullary division $\times 50$

Fig 16 Thymus from hatching chick given 100 μ c on fourteenth day of incubation It is smaller than control in Fig 14 and its cortex shows loss of lymphocytes $\times 50$

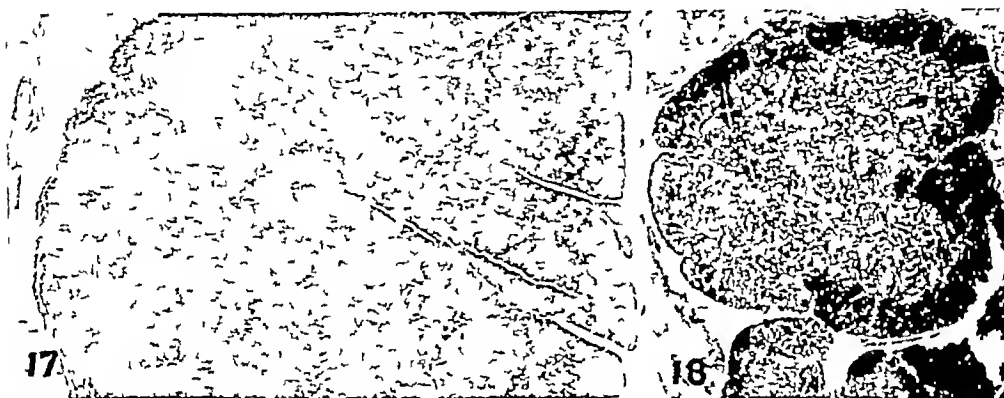


Fig 17 Section through thymus of normal fifteen-day chick Cortico-medullary structure is well formed and cortex is densely packed with lymphocytes $\times 40$

Fig 18 Thymus from fifteen-day chick given 200 μ c on eighth day of incubation It is markedly hypoplastic Cortex is poorly developed and in some places absent entirely Because of the small size of the thymus the Hassall's corpuscles are closer together than normal and give the impression of relative increase $\times 40$

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Injection of chicks produced an injury and recovery similar to that found in irradiated embryos, the injury being proportional to the amount of radiation. The fatal and near-fatal doses produce changes identical to those seen in the moribund fifteen-day chicks given 200 μ c on the eighth day of incubation.

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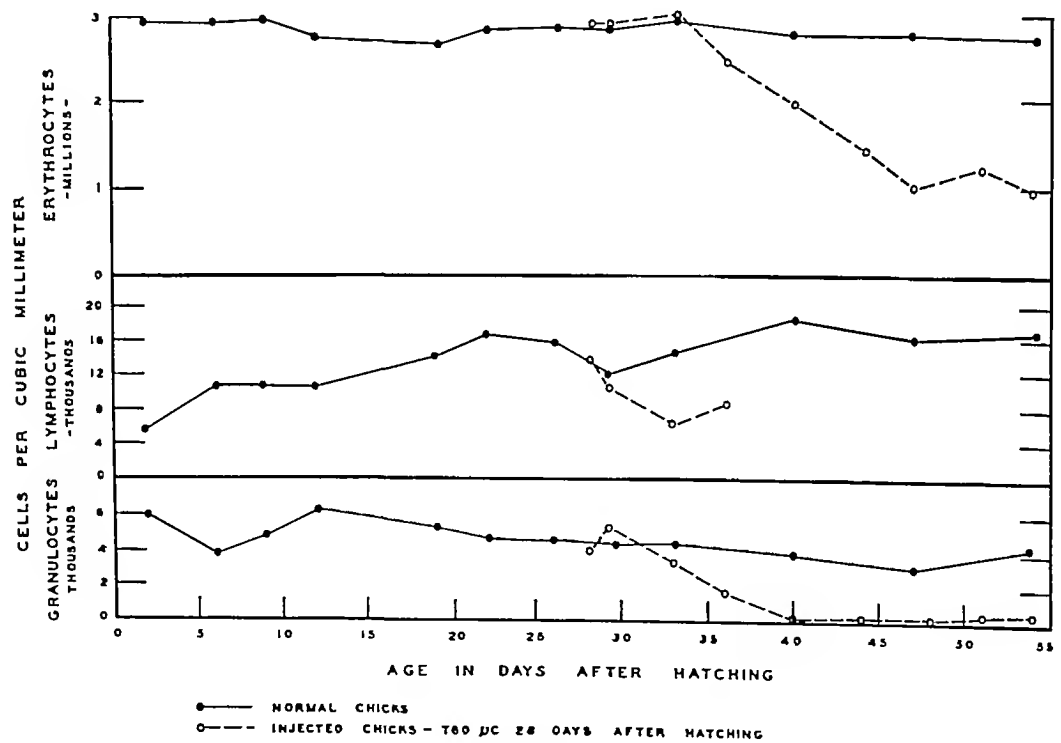
This occurred even with the smallest dose of 100 μ c. Only the gonads showed as early a response as this.

Second, regeneration of lymphoid tissue was rapid and started soon after injury. Except when large doses were given to young embryos, recovery was complete even in animals dying from anemia. Recovery was initiated from two to six days after the most severe depression of mitotic activity and was complete usually in less than three weeks. The histologic recovery of the thymus was more rapid than the recovery of the circulating lymphocyte count. The excellent recovery was no doubt due to the short duration of the injury. This was greatest during the

to radiation seen in the two preceding groups was repeated here. The lymphocyte count dropped sharply the first day and then more gradually, reaching a low of 6,000 per cu mm in five days before recovery began. No accurate lymphocyte counts could be calculated after the thirty-sixth day of age. The red count remained unchanged for five days and then fell off, reaching 1,000,000 per cu mm nineteen days after injection and staying near this level throughout the remaining week of ob-

and reaching a low point within three to five days after onset of radiation. The return to normal varied with the amount of radiation, and was shorter for lymphocytes than the other cell types, but was not as rapid as evidence of histologic repair in the thymus. The granulocytes dropped more gradually, and virtual agranulocytosis resulted in about two weeks. The recovery phase for the granulocytes was longer than for the other cell types. The red count remained within normal levels

BLOOD COUNTS



Graph III

servation. The granulocyte count rose slightly one day after injection and then fell gradually, these cells almost completely disappearing from the circulation twelve days after injection. This near-agranulocytic level was maintained throughout the remaining two weeks of observation.

Discussion All groups showed the same general pattern of peripheral blood cell changes during and following irradiation. The lymphocyte count was affected first, falling sharply in the first few days

for several days and then gradually fell, reaching a low value in fifteen or twenty days. The recovery phase was only slightly longer than for the lymphocytes.

The lag period after irradiation before the fall of the red count is much longer in animals with non-nucleated red cells. Since the lag period is related to the length of life of circulating cells, it would appear likely that the circulating nucleated red blood cell in the chick is shorter-lived than non-nucleated red blood cells in mammals.

SUMMARY

Internal irradiation by P^{32} in smaller doses inhibited maturation of the immature hematopoietic cells and reduced the mitotic activity. These changes were reversible and after the radiation had diminished, the bone marrow returned to normal. The larger doses of radiation, which eventually caused a fatal anemia, produced an immediate and virtually complete cessation of mitotic activity and maturation. In this group, after the radiation had decreased significantly, the few remaining hematopoietic and reticulo-endothelial cells began to show mitotic activity and maturation, but in an amount insufficient to prevent the development of an anemia which proved fatal several days later.

The lymphoid tissue of the thymus was very sensitive to radiation and showed an almost immediate marked reduction of mitotic activity, which lasted until most of the retained P^{32} had been concentrated

in the bones. Recovery was rapid, and all but the most severe of these injuries were reversible.

Peripheral blood counts followed a definite pattern during and following irradiation. The lymphocyte count fell first and recovered before the other cell types. The granulocyte count fell next most rapidly and recovered most slowly. The red cell count dropped most slowly and returned to normal midway between lymphocyte and granulocyte counts.

NOTE. The authors are indebted to Dr. Olive Gates for invaluable assistance in this work.

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SUMARIO

Efectos de la Irradiación Continua sobre los Embriones de Pollo y los Pollos en Vías de Desarrollo II. Médula Ósea, Tejido Linfóide y Sangre Periférica

Continuando sus estudios de los efectos de la irradiación continua, con P^{32} , sobre los embriones de pollo y los pollos en desarrollo, los AA. estudiaron la médula ósea, el tejido linfóide y la sangre periférica.

Las dosis más pequeñas de irradiación interna con P^{32} inhibieron la maduración de las células hematopoyéticas inmaduras y atenuaron la actividad carioquénica. Esas alteraciones fueron reversibles, y después de disminuir la irradiación, la médula ósea volvió a lo normal. Las dosis mayores de rayos, que con el tiempo provocaron anemia letal, produjeron cese inmediato y virtualmente completo de la carioquinesis y la maduración. En este grupo, después de disminuir significativamente la irradiación, las pocas células hematopoyéticas y reticuloendoteliales restantes comenzaron a revelar actividad carioquénica y maduración, pero en proporción insuficiente para impedir la

aparición de una anemia que resultó letal pocos días después.

El tejido linfóide del timo se mostró muy sensible a la irradiación y reveló casi inmediatamente baja decidida de la carioquinesis que duró hasta que la mayor parte del P^{32} retenido se había concentrado en los huesos. La reposición fué rápida, y todas las lesiones, aparte de las más graves, fueron reversibles.

Las numeraciones de la sangre periférica se conformaron a un patrón bien definido durante la irradiación y después. La fórmula linfocitaria bajó y se repuso antes que las de las otras células. La fórmula granulocitaria vino después en la rapidez de su descenso y fué la que se repuso con mayor lentitud. La eritrocitaria fué la que descendió más lentamente y en su retorno a lo normal ocupó un puesto medio entre la linfocitaria y la granulocitaria.

EDITORIAL

Fluoroscopy vs Films in the Gastro-Intestinal Examination

The question of the relative values of fluoroscopy and radiography in the roentgen diagnosis of lesions of the gastro-intestinal tract has been perennially debated since the early days of roentgenology. In this country, Carman was a brilliant protagonist of the fluoroscopic examination, developing it to such a high degree that radiography, in his hands and those of his followers, assumed secondary importance. Cole and his associates, on the contrary, were strongly convinced that serial roentgenograms taken in several positions, to show all parts of the stomach, were the primary requisite for exact diagnosis. These opposing views have undergone many modifications with the passage of the years until today a standard gastro-intestinal study usually represents a skillful blending of the two.

Other factors have come to play a role from time to time, and each has left its imprint on the general picture. The danger to the operator inherent in fluoroscopy was early recognized, and even Carman (1), the foremost advocate of the method, warned of its attendant hazards, especially damage to the blood and blood-forming organs. The increasing incidence of diseases of the hemopoietic system among radiologists is ample proof that this warning was timely and—unfortunately—that it has been too largely disregarded. Spot-film radiography has slowly come into the picture and has found numerous advocates of various degrees of enthusiasm. Many have used it hesitantly because of the fear of roentgen injury either to the patient or to the operator. More recently photoroentgenography, with multiple exposures on small films, has entered the field, and its possibilities for supplanting the older

methods of examination are being explored at several radiological centers.

In a Symposium presented at the 1948 meeting of the Radiological Society of North America, printed in the present issue of *RADIOLOGY*, the various aspects of this problem are discussed in the light of modern roentgenology. Harris furnishes a well rounded picture of the technic of fluoroscopy and the results which may be attained by its use. He holds it to be of prime importance in the diagnosis of lesions of the stomach and duodenal cap and regards films as of secondary significance. Templeton, while agreeing that fluoroscopy is an essential part of the examination, believes that films will often reveal lesions which the fluoroscopist has missed, and that the objective evidence which they furnish is of definite advantage. He advocates the use of the filming fluoroscope to obtain serial films of all parts of the stomach and amplifies the details of this technic in his discussion following the symposium. Morgan has contributed valuable information regarding the physical problems of fluoroscopy and spot-film radiography and offers practical suggestions for safeguarding both the patient and the radiologist—a matter which requires periodic reiteration. The excellent papers on gastroscopy, by Dailey, and on the clinical aspects of peptic ulcer, by Wilbur and Watts, round out the discussion and are deserving of careful study.

In reaching a decision as to the technic to be followed in examination of the gastro-intestinal tract, one must consider the ends to be accomplished. It goes without saying that the primary objective is an accurate diagnosis of the earliest manifestations of any organic lesion, more es-

pecially cancer. This granted, certain other considerations call for attention. In institutions where the emphasis is upon teaching, it is inevitable that films will play a prominent role, as the fluoroscopic image can be viewed by relatively few students. A similar condition will obtain in situations where the referring physician is accustomed personally to review the films. In clinics where routine gastro-intestinal studies are a common practice, the radiologist may decide upon the type of procedure which he feels will assure a high degree of accuracy without unduly prolonging the exposure time. It is thus apparent that no one type of examination can arbitrarily be designated the "best" for all radiologists or all institutions.

Where large numbers of gastro-intestinal studies are performed, with a considerable radiation exposure, it is acknowledged that there is a measurable risk involved. It is also pretty generally agreed that, under present conditions, in spite of this potential danger, fluoroscopy must occupy an important place in the examination. It behooves the radiologist, therefore, to see that his department is sufficiently staffed to permit a rotation of work, so that each fluoroscopist may regularly spend a certain number of days at duties not involving exposure to radiation. Nor can too strong emphasis be placed upon adequate protection in the form of lead rubber aprons and gloves, which are all too often omitted because of the inconvenience attending their use. The dangers of secondary radiation and how best to minimize them have been clearly pointed out by Morgan. Careful attention to

these details will eliminate many of the hazards of fluoroscopy. Our younger men should be taught full respect for the dangers of radiation—as well as for its usefulness—and should be instructed as to the means of circumventing injury by observing simple rules of protection.

Technical changes are taking place that are modifying and may ultimately change completely our methods of gastro-intestinal examination. Already mass surveys are being made by Morgan (3) with the Schmidt camera. Others (2, 4) are conducting similar studies by fluoroscopy alone or in combination with films. The fluoroscopic method may itself be revolutionized, and its diagnostic efficiency multiplied, by further development of recently suggested procedures for amplification of the fluoroscopic image. With the clinical demands for mass surveys and the introduction of improved methods for their accomplishment, it is not beyond the realm of possibility that, like similar surveys in the field of tuberculosis, these may be used to screen out the normal subjects, while more complete examinations are reserved for those with evidence of an organic lesion.

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POSTGRADUATE COURSE IN MEDICAL ASPECTS OF NUCLEAR ENERGY UNIVERSITY OF CALIFORNIA

A postgraduate course in the medical aspects of nuclear energy is being offered at the University of California, San Francisco, Aug 29 through Sept 3, 1949. Dr Joseph G Hamilton, Associate Professor of Experimental Medicine and Radiology, University of California Medical School, and Associate Professor of Medical Physics and Director of the Crocker Laboratory, University of California, is General Chairman of the course. Other officers of instruction include, Luis W Alvarez, Ph D, Austen M Brues, M D, Simeon Cantril, M D, Andrew H Dowdy, M D, John Gofman, Ph D, M D, John H Lawrence, M D, Bertram V A Low-Beer, M D, Edwin M McMillan, Ph D, Stacy R Mettler, M D, Earl R Miller, M D, Edith H Quimby, Sc.D, Kenneth W Scott, Ph D, Glenn T Seaborg, Ph D, Curt Stern, Ph D, Robert S Stone, M D, Robert L Thornton, Ph D, Shields Warren, M D, Stafford Warren, M D.

Inquiries as to enrollment should be addressed to Stacy R Mettler, M D, Office of Medical Extension, University of California Medical Center, San Francisco 22, Calif

BROOKLYN ROENTGEN RAY SOCIETY

At a recent meeting of the Brooklyn Roentgen Ray Society, the following officers were elected for the ensuing year: President, Dr John Pepe, Vice-President, Dr B Ehrenpreis, Secretary-Treasurer, Dr J Daversa, 603 Fourth Ave., Brooklyn, N Y

CHICAGO ROENTGEN SOCIETY

The newly elected officers of the Chicago Roentgen Society, for 1949-50, are: T J Wachowski, M D, President; Frank Hussey, M D, Vice President; John H Gilmore, M D, 720 N Michigan Ave., Chicago 11, Secretary-Treasurer.

ARGENTINE RADIOLOGICAL ASSOCIATION

The newly organized Asociación Argentina de Radiología has announced plans for its Primer Congreso de Radiología to be held in Santiago del Estero, Argentina, in July 1949. The following are the official themes of the congress: Radiologic Exploration of the Bronchopulmonary System; Radiology of Bronchopulmonary Tumors; Radiology of Gastric Diseases; Radiology of the Extrahepatic Biliary Tract; Radiotherapy of Cutaneous Affections.

The President of the Association is Dr Sabino

Di Rienzo, Vice-President; Dr Juan I Zorrilla, General Secretary; Dr Jose R Aguirre, Permanent Secretary; Dr Lidio G Mosca, Tucuman 275, Santiago del Estero, Argentine; Treasurer, Dr Robert Alvarez.

SUGGESTED MODEL CONTRACT FOR HOSPITAL RADIOLOGISTS

The attention of radiologists is called to a suggested model contract for hospital radiologists, appearing in *California Medicine* for April 1949. This contract was prepared by and as a result of joint conferences between legal counsel for the California Medical Association and counsel for the Association of California Hospitals. It has been approved by the Council of the Medical Association and at the time of publication was awaiting final action by a special committee of the hospital group.

DR EDITH H QUIMBY HONORED

Dr Edith H Quimby, Associate Professor of Radiology at the College of Physicians and Surgeons, Columbia University, was the recipient of one of the four American Design Awards for creative thinking annually presented by the firm of Lord & Taylor, New York City. The award, which was made at a luncheon at the Waldorf Astoria, on May 4, was in recognition of Dr Quimby's work with radioactive materials.

BOOKS FOR CHILE

The National Committee for Chile is soliciting copies of medical periodicals of the last ten years and recent medical books for the library of the Medical School of the University of Chile, to replace reference material recently destroyed by fire. Any contributions should be sent to the National Committee for Chile, Room 318, Library of Congress, Washington, D C.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CARDIAC CATHETERIZATION IN CONGENITAL HEART DISEASE. A CLINICAL AND PHYSIOLOGICAL STUDY IN INFANTS AND CHILDREN. By ANDRÉ COURNAND, M D, Associate Professor, Department of Medicine, College of Physicians and Surgeons, Columbia University; JANET S BALDWIN, M D, Assistant Professor, Department of

Pediatrics, New York University College of Medicine, and AARON HIMMELSTEIN, M D, Instructor, Department of Surgery, College of Physicians and Surgeons, Columbia University. A volume of 108 pages, with numerous illustrations. Published by The Commonwealth Fund, New York, 1949. Price \$4.00.

ATEMREGELUNG ALS HEILMITTEL. By Prof. Dr. LUDWIG HOFBAUER, Union University, Albany 3, N. Y. A volume of 100 pages, with 33 illustrations. Published by Wilhelm Maudrich, Wien, Austria, 1948. Price \$2.50.

Book Reviews

LUNG DUST LESIONS (PNEUMOCONIOSIS) VERSUS TUBERCULOSIS. By LEWIS GREGORY COLE, M D, F R C R. A volume of 474 pages, with over 400 illustrations. Published by American Medical Films, Inc., White Plains, N. Y., 1948. Price \$10.00.

In 1940, Lewis Gregory Cole, then Director of Silicotic Research for the John B. Pierce Foundation, and his son, the late William Gregory Cole, published their *Story of Dusty Lungs: A Preliminary Report*. There now appears this more elaborate treatise, summarizing the observations of these two investigators over a period of some fourteen years. They were assisted in their studies by many other workers in this field, to whom generous credit is given for case reports, specimens, and special forms of clinical and technical aid.

Dr. Cole states that his object has been to study the lungs of persons who have inhaled various quantities and qualities of dust and to present the results in simple terms with suitable illustrations, to describe the roentgen observations in such cases, and to correlate these with the pathological findings. He has sought further to distinguish dust lesions from those of other pathology and, finally, to apply the data which he has assembled to certain social and economic problems growing out of dust exposure in industry.

As the title indicates, particular stress is placed upon the similarity of many dust lesions to tuberculosis and the importance of comparing and differentiating the two, to which end a lavish use has been made of roentgenograms, photomicrographs, and drawings. The concluding chapter of the work is devoted to matters of technic, including details of the roentgenographic demonstration of chest lesions and a step-by-step description of the procedure employed for obtaining photomicrographs.

Dr. Cole's handling of his subject is original and stimulating, its very unorthodoxy contributing to its interest. Workers in this field will find this volume not only informative but thought-provoking to a high degree.

A SYMPOSIUM ON THE USE OF ISOTOPES IN BIOLOGY AND MEDICINE. Contributions by nineteen leading scientists. Report of a Conference conducted at the University of Wisconsin, Madison, Wis., September 1947. A volume of 446 pages. Published by the University of Wisconsin Press, Madison, Wis., 1948. Price \$5.00.

There was held at the University of Wisconsin, in September 1947, a Symposium on isotopic research as applied to medicine and biology, participated in by the nation's leaders in this new field of study. The major papers of the Symposium are now published in book form, offering in the scope of a few hundred pages an authoritative exposition of this subject by those most highly qualified to discuss it.

An introductory chapter, furnishing an historical background for the use of isotopes in biochemistry, is followed by several papers on the preparation and availability of isotopes and their distribution by the Atomic Energy Commission, a group of technical articles on the preparation of compounds and measurements of radioactivity, a series on the results of tracer studies and their medical applications, a chapter on the therapeutic use of radioactive phosphorus and one on the treatment of thyroid disease by radioiodine. Two chapters are devoted to health hazards in the use of radioactive isotopes and measures for the protection of property and personnel. The concluding papers on the political and social implications of atomic energy sum up the attitude of the scientist to what is unquestionably the most serious problem of our time.

The number who had the privilege of attending the Symposium at Madison was limited. It is well to have made available to others who are interested in this new field of research the wealth of material that was presented there. This book is recommended as an authoritative and useful source of information to all who are engaged in research in the clinical application of isotopes to medicine and biology and to the far greater number who look with interest to the results of such investigations.

MEDICAL X-RAY PROTECTION UP TO TWO MILLION VOLTS. National Bureau of Standards Handbook 41, Issued March 30, 1949 (superseding Handbook 20). For sale by the Superintendent of Documents, Washington, D. C. Price 15 cents.

This handbook on roentgen protection was prepared by a Subcommittee made up of H. O. Wyckoff, Chairman, C. B. Braestrup, L. L. Call, E. E. Charlton, A. C. Cipollaro, M. D., M. Friedman, M. D., Russell Morgan, M. D., R. R. Newell, M. D., E. W. Philleo, Scott W. Smith, John Trump, and J. L. Weatherwax. It sets forth concisely standards of safety for the installation and use of high voltage x-ray equipment. For further details of its preparation and content, see the Editorial by Dr. Lauriston Taylor in *RADIOLOGY* for May 1949.

RADIOLOGICAL SOCIETIES SECRETARIES AND MEETING DATES

Editor's Note Secretaries of state and local radiological societies are requested to co-operate in keeping this section up to-date by notifying the editor promptly of changes in officers and meeting dates

RADIOLOGICAL SOCIETY OF NORTH AMERICA *Secretary-Treasurer*, Donald S Childs, M D, 713 E Genesee St., Syracuse 2, N Y

AMERICAN RADIUM SOCIETY *Secretary*, Hugh F Hare, M D, 605 Commonwealth Ave., Boston 15, Mass

AMERICAN ROENTGEN RAY SOCIETY *Secretary*, Harold Dabney Kert, M D, Iowa City, Iowa

AMERICAN COLLEGE OF RADIOLOGY *Secretary*, William C Stronach, 20 N Wacker Dr., Chicago 6, Ill

SECTION ON RADIOLOGY, A M A *Secretary*, U V Portmann, M D, Cleveland Clinic, Cleveland 6, Ohio

Alabama

ALABAMA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, W D Anderson, M D, 2501 6th St., Tuscaloosa.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY *Secretary*, Fred Hames, M D, Pine Bluff Meets every three months and at meeting of State Medical Society

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY *Secretary*, Sydney F Thomas, M D, Palo Alto Clinic Palo Alto

EAST BAY ROENTGEN SOCIETY *Secretary*, Dan Tucker, 434 30th St., Oakland 9 Meets monthly, first Thursday, at Peralta Hospital

LOS ANGELES RADIOLOGICAL SOCIETY *Secretary*, Wybren Hiemstra, 1414 S Hope St. Meets monthly, second Wednesday, County Society Bldg

NORTHERN CALIFORNIA RADIOLOGICAL CLUB *Secretary*, Charles E Grayson, M D, Medico-Dental Bldg., Sacramento 14 Meets at dinner last Monday of September, November, January, March, and May

PACIFIC ROENTGEN SOCIETY *Secretary*, L Henry Garland, M D, 450 Sutter St., San Francisco 8 Meets annually with State Medical Association

SAN DIEGO ROENTGEN SOCIETY *Secretary*, R P Niehaus, M D, 1831 Fourth Ave., San Diego Meets first Wednesday of each month

X-RAY STUDY CLUB OF SAN FRANCISCO *Secretary*, Wm F Reynolds, M D, University Hospital, San Francisco 22 Meets third Thursday at 7 45, January to June at Stanford University Hospital, July to December at San Francisco Hospital

Colorado

COLORADO RADIOLOGICAL SOCIETY *Secretary*, Mark S Donovan M D 306 Majestic Bldg., Denver 2 Meets third Friday of each month, at the Colorado School of Medicine and Hospitals

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY *Secretary*, Fred Ziff, M D, 135 Whitney Ave New Haven Meetings bimonthly, second Wednesday

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY *Secretary*, Ellwood W Godfrey, M D, 1676 Boulevard, W Hartford Meets second Friday of October and April

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY *Secretary*, Alfred A J Den, M D, 1801 K St., N W, Washington 6 Meets third Thursday, January, March, May, and October, at 8 00 P M, in Medical Society Auditorium

Florida

FLORIDA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, F K Hurt, M D, Riverside Hospital, Jacksonville. Meets in April and in November

Georgia

ATLANTA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Wm W Bryan, M D, 490 Peachtree St., N E Meets second Friday September to May

GEORGIA RADIOLOGICAL SOCIETY *Secretary Treasurer*, Robert Drane, M D, De Renne Apartments, Savannah Meets in November and at the annual meeting of State Medical Association

Illinois

CHICAGO ROENTGEN SOCIETY *Secretary*, John H Gilmore, M D, 720 N Michigan Ave., Chicago 11 Meets at the Palmer House, second Thursday of October November, January, February, March, and April at 8 00 P M

ILLINOIS RADIOLOGICAL SOCIETY *Secretary-Treasurer*, William DeHollander, M D, St. Johns' Hospital, Springfield Meetings quarterly as announced

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY *Secretary*, Harold L Shinall, M D, St Joseph's Hospital, Bloomington

Indiana

INDIANA ROENTGEN SOCIETY *Secretary-Treasurer*, William M Loehr, M D, 712 Hume-Mansur Bldg., Indianapolis 4 Annual meeting in May

Iowa

IOWA X-RAY CLUB *Secretary*, Arthur W Erskine, M D, 326 Higley Building, Cedar Rapids Meets during annual session of State Medical Society

Kansas

KANSAS RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Anthony F Rossitto, M D, Wichita Hospital, Wichita Meets annually with State Medical Society

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY *Secretary Treasurer*, Everett L Pirkey, M D, 323 East Chestnut St., Louisville 2

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2 Meets second Friday of each month at Louisville General Hospital

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Johnson R. Anderson, M D, No. Louisiana Sanitarium, Shreveport Meets with State Medical Society

ORLEANS PARISH RADIOLOGICAL SOCIETY *Secretary*, Joseph V. Schlosser, M D, Charity Hospital of Louisiana, New Orleans 13 Meets first Tuesday of each month

SHREVEPORT RADIOLOGICAL CLUB *Secretary* Oscar O. Jones, M D, 2622 Greenwood Road. Meets monthly September to May, third Wednesday

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION *Secretary*, J. Howard Franz, M D, 1127 St. Paul St., Baltimore 2

Michigan

DETROIT X-RAY AND RADIUM SOCIETY *Secretary-Treasurer*, George Belanger, M D, Harper Hospital, Detroit 1 Meets first Thursday, October to May, at Wayne County Medical Society clubrooms

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS *Secretary-Treasurer*, R. B. MacDuff, M D, 220 Genesee Bank Building, Flint 3

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY *Secretary*, C. N. Borman, M D, 802 Medical Arts Bldg. Minneapolis 2 Meets in Spring and Fall

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY *Secretary*, Wm. M. Kitchen, M D, 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month

ST. LOUIS SOCIETY OF RADIOLOGISTS *Secretary*, Charles J. Nolan, M D, 737 University Club Bldg. Meets on fourth Wednesday, October to May

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Ralph C. Moore, M D, Nebraska Methodist Hospital, Omaha 3 Meets third Wednesday of each month at 6 P. M. in Omaha or Lincoln

New England

NEW ENGLAND ROENTGEN RAY SOCIETY *Secretary-Treasurer*, George Levene, M D, Massachusetts Memorial Hospitals, Boston Meets monthly on third Friday at Boston Medical Library

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY *Secretary-Treasurer* Albert C. Johnston, M D, Elliot Community Hospital Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY *Secretary*, Raphael Pomeranz, M D, 31 Lincoln Park, Newark 2 Meetings at Atlantic City at time of State Medical Society and midwinter in Newark.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M D, East Rockaway

BROOKLYN ROENTGEN RAY SOCIETY *Secretary-Treasurer*, J. Daversa, M D, 603 Fourth Ave., Brooklyn Meets fourth Tuesday of each month, October to April

BUFFALO RADIOLOGICAL SOCIETY *Secretary-Treasurer* Mario C. Gian, M D, 610 Niagara St., Buffalo 1 Meetings second Monday, October to May

CENTRAL NEW YORK ROENTGEN SOCIETY *Secretary-Treasurer*, Dwight V. Needham, M D, 608 E. Genesee St., Syracuse 10 Meetings in January, May, and October

LONG ISLAND RADIOLOGICAL SOCIETY *Secretary*, Marcus Wiener, M D, 1430 48th St., Brooklyn 19 Meetings fourth Thursday evening, October to May, at 8 45 P. M., in Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY *Secretary*, Wm. Snow, M D, 941 Park Ave., New York 28

QUEENS ROENTGEN RAY SOCIETY *Secretary*, Jacob E. Goldstein, M D, 88-29 163rd St., Jamaica 3 Meets fourth Monday of each month

ROCHESTER ROENTGEN-RAY SOCIETY *Secretary-Treasurer*, Ralph E. Alexander, M D, 101 Medical Arts Bldg., Rochester 7 Meets at Strong Memorial Hospital, third Monday, September through May

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M D, Professional Bldg., Charlotte 2 Meets in May and October

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY *Secretary*, Charles Heilman, M D, 1338 Second St., N. Fargo

Ohio

OHIO STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Carroll Dundon, M D, 2065 Adelbert Road Cleveland 6 Next meeting at annual meeting of the State Medical Association

CENTRAL OHIO RADIOLOGICAL SOCIETY *Secretary*, Paul D. Meyer, M D, Grant Hospital, Columbus Meets second Thursday, October, December, February, April, and June, 6 30 P. M., Seneca Hotel, Columbus

CINCINNATI RADIOLOGICAL SOCIETY *Secretary*, Eugene L. Saenger, M D, 735 Doctors Bldg., Cincinnati 2 Meets last Monday, September to May

CLEVELAND RADIOLOGICAL SOCIETY *Secretary-Treasurer* John R. Hannan, M D, Cleveland Clinic, Cleveland 6 Meetings at 6 30 P. M. on fourth Monday October to April inclusive

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, W E Brown, M D, 21st and Xanthus, Tulsa 4 Meets in October, January, and May

Oregon

OREGON RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Boyd Isenhardt, M D, 214 Medical-Dental Bldg, Portland 5 Meets monthly, on the second Wednesday, at 8 00 P M, in the library of the University of Oregon Medical School

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Sydney J Hawley, M D, 1320 Madison St, Seattle 4, Wash Meets annually in May

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY *Secretary-Treasurer*, James M Converse, M D, 416 Pine St., Williamsport 8 Meets annually

PHILADELPHIA ROENTGEN RAY SOCIETY *Secretary*, Arthur Finkelstein, M D, Graduate Hospital, Philadelphia Meets first Thursday of each month at 8 00 P M, from October to May, in Thomson Hall, College of Physicians, 21 S 22d St

PITTSBURGH ROENTGEN SOCIETY *Secretary-Treasurer*, R P Meader, M D, 4002 Jenkins Arcade, Pittsburgh 22 Meets second Wednesday of each month at 6 30 P M, October to June.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Maurice D Frazer, M D, Lincoln Clinic, Lincoln, Nebr Next meeting in Denver, Colo, Aug 18-20, 1949

South Carolina

SOUTH CAROLINA X-RAY SOCIETY *Secretary-Treasurer*, Robert B Taft, M D, 103 Rutledge Ave., Charleston 16

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA *Secretary-Treasurer*, Marianne Wallis, M D, 1200 E Fifth Ave, Mitchell Meets during Annual Session of State Medical Society

Tennessee

MEMPHIS ROENTGEN CLUB Meetings second Tuesday of each month at University Center

TENNESSEE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, J Marsh Frère, M D, 707 Walnut St., Chattanooga Meets annually with State Medical Society in April

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB *Secretary*, X R Hyde M D, Medical Arts Bldg, Fort Worth 2 Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months

HOUSTON X-RAY CLUB *Secretary*, Curtis H Burge, M D, 3020 San Jacinto, Houston 4 Meetings fourth Monday of each month

TEXAS RADIOLOGICAL SOCIETY *Secretary-Treasurer*, R P O'Bannon, M D, 650 Fifth Ave, Fort Worth Next meeting Feb 3-4, 1950, in Dallas

Utah

UTAH STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Angus K Wilson, M D, 343 S Main St, Salt Lake City Meets third Wednesday, January, March, May, September, November

Virginia

VIRGINIA RADIOLOGICAL SOCIETY *Secretary*, P B Parsons, M D, Norfolk General Hospital, Norfolk 7

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY *Secretary-Treasurer*, Homer V Hartzell, M D, 310 Stimson Bldg, Seattle 1 Meetings fourth Monday, October through May, at College Club, Seattle

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY *Secretary-Treasurer*, Theodore J Pfeffer, M D, 839 N Marshall St, Milwaukee 2 Meets monthly on second Monday at the University Club

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY *Secretary*, S R Beatty, M D, 185 Hazel St, Oshkosh Two-day meeting in May, one-day with State Medical Society, September

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE Meets first and third Thursdays 4 P M, September to May, Service Memorial Institute, Madison 6

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA *Secretary*, Jesus Rivera Otero, M D, Box 3542, San-turce, Puerto Rico

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS *Honorary Secretary-Treasurer*, E M Crawford, M D Associate *Honorary Secretary-Treasurer*, Jean Bouchard, M D *Central Office*, 1535 Sherbrooke St, West, Montreal 20, Quebec Meetings in January and June

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES *General Secretary*, Origène Dufresne, M D, Institut du Radium, Montreal Meets third Saturday each month

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA Offices in Hospital Mercedes, Havana Meets monthly

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA, *General Secretary*, Dr Dionisio Pérez Cosío, Marsella 11, México, D. F Meetings first Monday of each month

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Pathologic Non-Neoplastic Intracranial Calcification.
John D Camp J A M A 137 1023-1030, July 17, 1948

In this excellent summary the author has classified intracranial calcification of non-neoplastic origin as follows

- 1 *Vascular lesions* Arteriosclerosis aneurysm, angiomatous malformations, and hematomas
- 2 *Inflammatory lesions* Previous encephalitis and tuberculosis
- 3 *Parasitic disease* Toxoplasmosis, cysticercosis, and trichinosis
- 4 *Degenerative lesions* Congenital or developmental in origin
- 5 *Tuberous sclerosis*
- 6 *Parathyroid insufficiency*

Although the reproductions in the journal are, unfortunately only fair it is recommended that the reader consult the original article PAUL W ROMAN, M D
Baltimore, Md

Atlanto-Epistropheic Luxation with Aplasia of the Dens Epistrophei. Kurt Nievergelt Schweiz med Wchnschr 78 653-657, July 10, 1948 (In German)

Four cases are reported in which hypoplasia or absence of the dens of the epistropheus, or its development as a separate ossicle, allowed forward luxation of the axis following trauma of varying severity For treatment of this condition the author prefers reduction under anesthesia and immobilization in plaster followed at a later date by operative fusion of the upper cervical vertebrae to the skull

Two roentgenograms, 2 photographs, 7 drawings
LEWIS G JACOBS, M D
Oakland, Calif

THE CHEST

Tumors of the Breast Preoperative Roentgenography J Gershon Cohen and Philip J Hodes Surg, Gynec & Obst 86 723-728, June 1948

The authors believe that roentgenographic examination of the breast as well as of the lungs and skeleton, should be employed routinely in the preoperative study of breast tumors Roentgenography of the breast itself is of greatest value in those cases where clinical examination and transillumination have failed as in the large fatty breast with a small tumor and the rarer deep lying breast mass protected from palpation by the overlying tissues Occasionally also, an additional lesion not suspected on physical examination is found In most other instances roentgenographic examination of the breast provides confirmation of a previously diagnosed tumor

In experienced hands the benign or malignant status of a tumor can often be judged but in any questionable case prompt biopsy is of course indicated The roentgenogram can further aid the surgeon by delineating the pathological structure of the lesion and it provides a record for comparison in those lesions that change in size from time to time

The authors point out that the proper roentgen interpretation of breast tumors is extremely difficult, requiring excellent technic and considerable experience An examination of both breasts and axillae should be included so that the metastatic, as well as the primary lesion, can be studied The differential densities of the skin, subcutaneous fat, veins, lipid tissue of the breast, glandular elements, and fascia of the suspensory ligaments, permit roentgenographic visualization of these structures Infiltration and proliferation of large cell masses are thus identified by the changes in mammary architecture which they produce, and by their delineation within the surrounding lipid structure

The roentgenographic changes seen in other breast conditions than neoplasms are also outlined

Twelve illustrations, including 4 roentgenograms

D B NAGLE, M D
University of Pennsylvania

Differential Diagnosis of Pulmonary Lesions
Stanley B Clark New York State J Med 48 1587-1592 July 15, 1948

This is a paper written by a roentgenologist as a guide for physicians in general practice who most often are the first to encounter pulmonary lesions and who first have occasion to correlate clinical, pathologic, and roentgenologic data in attempting to arrive at a correct diagnosis The pathologic and roentgenologic findings are presented with this in mind, and the lesions are grouped according to the underlying process The main headings with the subjects included under them, are as follows *Destruction of Pulmonary Tissue* lung abscess and gangrene of the lung, bronchiectasis, tuberculosis and the pneumoconioses *Consolidation of Pulmonary Alveoli* lobar or pneumococcal pneumonia, passive congestion, and pulmonary infarction *Changes in Intrathoracic Tension* atelectasis and emphysema *Lesions Primarily Interstitial in Location* primary atypical pneumonia and Boeck's sarcoid *Replacement of Normal Pulmonary Tissue by a Pathologic Process* primary and metastatic lung tumors *Alteration in Pleural Density* pleural thickening and pleural tumors

Shadows Resembling a Cavity in Laminagrams, due to a Shell Fragment in the Chest Wall Roger Even and Guy Morin J franç de méd et chir thoraciques 2 260-261, 1948 (In French)

On routine chest fluoroscopy in a young adult male, a suspicious left infraclavicular shadow was noted Standard films were reported negative but laminagrams revealed a shell fragment in the right lateral chest wall at a depth of 4 cm from the back which had not been detected in the routine film As more anterior segments were obtained with the laminagraph a rounded translucent shadow was observed anterior to the foreign body, increasing in size as one neared the chest wall These ring shadows were judged to represent artefacts

The authors state that highly opaque shadows in laminagraphic films produce images in other planes and that the image increases in size as the sections are taken progressively farther from the opacity The configuration of the shadows depends on the type of apparatus used In machines using a linear motion, the shadow is

linear and streaky, resembling the drooping foliage of a willow tree, while in machines using a circular motion the artefact is circular in shape. A warning is given to be on the alert for such a phenomenon in the case of highly opaque calcifications in the chest producing false shadows of cavities.

Two roentgenograms E M SAVIGNAC, M D
Detroit, Mich

Diagnosis and Treatment of Bronchiectasis George E Spencer and Edward M Kent Pennsylvania M J 51 1122-1127, July 1948

Bronchiectasis is the second most common disease of the lungs, being surpassed in incidence only by tuberculosis. It frequently goes undiagnosed, the symptoms being attributed to chronic bronchitis or asthma. There are four types: ulcerative, stenotic, fibrotic, and dry hemorrhagic. The disease usually involves one of the lower lobes at first but advances to other lobes as it progresses.

By far the most important procedure for the diagnosis of bronchiectasis is bronchography. This is best done in the morning, with the patient fasting. After a preliminary gargle with 0.5 per cent pontocain solution, he is seated on a stool in the fluoroscopic room, the tongue is grasped with the fingers and 10 per cent pontocain is allowed to drip onto the back of it, as the patient breathes quietly. Up to 10 c.c. of the anesthetic may be used. The iodized oil is then administered by dropping it on the back of the tongue while the patient 'pants like a dog'. He is instructed to lean to one side while the first 10 c.c. are administered and to the other for the remaining 10 c.c. This insures filling of the bronchi of the right middle and lower lobes, the lingula of the left upper lobe, and the left lower lobe. If the upper bronchi are to be filled, the opaque oil is introduced through an intratracheal catheter with the patient on the fluoroscopic table, the head of which is lowered 5 to 10 degrees.

Postero anterior and oblique views are usually sufficient for diagnosis. If bronchiectasis is present, the filled cavities will be clearly demonstrated, resembling the branches of a dead tree or a bunch of grapes.

The most important medical measure is postural drainage, morning and night. In cases with disabling disease surgery may be indicated. Penicillin has become a major factor in preparation for operation. Lobectomy may be performed with surprisingly little postoperative discomfort.

Four roentgenograms JOSEPH T DANZER, M D
Oil City, Penna

Pathology of Reinfection Some Sources of Diagnostic Errors Walter Pagel and C H C Toussaint Am Rev Tuberc 58 85-97 July 1948

Reinfection is defined as a tuberculous infection occurring in a person in whom a previous primary infection is anatomically healed. The new lesion then will take the form of a focus at the site of entry of the tubercle bacilli followed by a caseous focus in the regional lymph nodes. The term superinfection is used to designate a repeated infection from without in a person in whom primary infection has not healed completely. The fresh focus of infection will not be followed by caseation in the regional lymph nodes.

To illustrate the difficulties of recognizing these types of tuberculosis clinically and pathologically, the authors employ a series of short case histories. These cases

mostly with postmortem observations include examples of endogenous infection of recent origin from an apparently obsolete primary lesion, persistence of the 'soft state' for a long time in either or both constituents of a primary complex, cases of reinfection as defined above, and lesions simulating reinfection.

Six roentgenograms, 5 photographs

L W PAUL, M D
University of Wisconsin

Non-Tuberculous Pulmonary Calcification John A Prior Ohio State M J 44 700-703, July 1948

The author conducted surveys, including chest roentgenograms and tuberculin and histoplasmin skin reactions, on a group of 5,087 Ohio State University freshmen and student nurses, all of whom were lifetime residents of some one county in Ohio. The southwestern segment of Ohio gave the highest incidence of histoplasmin positives, 75.8 per cent. The percentages tended to diminish in the neighboring areas, with the lowest incidence in the northeastern part of the state. Individuals coming from farm districts had a 9.5 per cent higher incidence of histoplasmin sensitivity than those coming from the cities. Sixteen per cent of those tested gave positive tuberculin reactions. Geographic differences were not apparent in this group, the incidence following the usual socio-economic pattern.

It is becoming increasingly apparent that not all parenchymal and hilar calcification is due to tuberculosis. A large percentage of such calcifications in individuals coming from the Southwestern States has been found to be due to *Coccidioides immitis*. Similarly, individuals coming from the Central Eastern States have parenchymal calcification due to histoplasmosis. Palmer (Pub Health Rep 61 425, 1946), who conducted a series of such tests, suggested that there may be a widespread benign form of histoplasmosis, as well as the more generally recognized fatal variety. Pulmonary calcification associated with positive histoplasmin reactions has been found to occur earlier in life than that in positive tuberculin reactors.

LOUIS BERNSTEIN, M D
Hartford, Conn

Besnier-Boeck-Schaumann's Disease with Pseudo-Cystic Pulmonary Shadows J Brun and J Viallier J franç de méd et chir thoraciques 2 273-276, 1948 (In French)

A 39 year-old male gave a long history of functional and neurasthenic complaints—weakness, night sweats, paresthesias in the legs, severe frontal headaches, and a stubborn productive cough. At the age of 35 following a long drawn out febrile episode with cough and abundant sputum a chest film was interpreted as showing evidence of tuberculosis. Despite prolonged care in and out of sanatoria, the functional disorders became more severe and frequent episodes of low-grade fever occurred, lasting two to three weeks with shortness of breath, severe chest pain and copious sputum.

When seen by the authors, the patient had been unable to work for two or three years. A series of roentgenograms extending over the past three years showed a bilateral widespread infiltration of the pulmonary parenchyma quite dense and rather homogeneous in character, interspersed with clear polycyclic areas in the median third of both lungs. Lipiodol did not enter

these areas and there was no bronchial dilatation. The tuberculin test, sputum studies, sedimentation rate, and blood count were all normal. An epitrochlear node showed epithelioid cells surrounded by lymphocytes but no giant cells. Guinea-pig inoculations remained negative. The diagnosis was Besnier-Boeck-Schaumann's disease.

It is pointed out that nervous complaints so frequently precede or accompany this disease that they should be looked for in its evolution. The pseudocystic form of the disease has been reported very rarely. The authors believe it is the result of secondary emphysematous changes in the lung parenchyma following a pulmonary sclerosis by sarcoid tissue. The process is somewhat similar to the lung damage in silicosis. In the case reported, at least, the changes appear irreversible, with a poor prognosis for functional rehabilitation.

One roentgenogram E M SAVIGNAC, M D
Detroit, Mich

Besnier-Boeck-Schaumann's Disease with Multiple Localizations and with Involvement of the Myocardium and of the Endocardium P Bonnet and J Brun. *J franç de méd et chir thoraciques* 2: 276-280, 1948 (In French)

The case reported here is that of a 17-year old girl who has been followed for four years. Her disease apparently evolved in two successive stages. At first there was a syndrome of uveoparotitis with paralysis of the 7th and 9th cranial nerves, a polyneuritis of the lower extremities and enlargement of the mediastinal nodes. After a considerable improvement there then developed a miliary type of pulmonary spread and cardiovascular involvement, with splenomegaly and enlargement of the axillary lymph nodes. There were only transient cutaneous manifestations of an erythema nodosum type followed by an erythematous macular rash on the legs. Roentgenograms of the bones showed no changes.

The cardiac lesions were manifested clinically and radiologically by enlargement of the heart chiefly of the left ventricle. A systolic murmur with transmission to the axilla developed along with a palpable thrill. The consulting cardiologist believed that a true mitral stenosis had developed with involvement of the endocardium by sarcoidosis. To date the literature has not mentioned endocardial sarcoidosis. Full proof is, of course, not available in this instance but in the absence of any clinically recognizable rheumatic fever, it was believed by all the consultants that the evidence was in favor of endocardial and myocardial sarcoidosis.

Two roentgenograms E M SAVIGNAC, M D
Detroit, Mich

Sarcoidosis Following Primary Tuberculosis. A Case Report. Joseph S Hiatt Jr. *Am Rev Tuberc* 58: 98-101, July 1948.

A case is reported of pulmonary sarcoidosis developing in a 10 year-old Negro girl who was under observation for primary tuberculosis. Roentgenograms of the chest previously had shown a partially calcified primary complex and the tuberculin test was positive. During a follow up examination approximately two and a half years later a considerable change was noted in the chest. There were linear and nodular densities throughout the lung fields and markedly enlarged mediastinal nodes. The previous primary complex remained unchanged.

Biopsy of an enlarged epitrochlear lymph node revealed the changes of Boeck's sarcoid. The chest lesions and enlarged peripheral nodes improved and six months later had largely disappeared.

Four roentgenograms

L W PAUL, M D
University of Wisconsin

Metastatic Pulmonary Cancer Secondary to a Symptomless Cancer of the Pancreas R Benda, F Franchel, and B Duperrat. *J franç de méd et chir thoraciques* 2: 268-272, 1948 (In French)

A 62-year-old woman suffering from chest pain, dyspnea, and a non-productive cough showed, on radiographic study of the chest, numerous closely packed, rounded opaque nodules measuring from 0.5 to 1.5 cm in diameter, widely disseminated throughout both lungs. A thorough examination, including intensive radiographic and laboratory studies, failed to reveal the origin of these. It is particularly mentioned that there was no evidence of pancreatic disease.

At autopsy the pancreas, though normal in size, was found on sectioning to be considerably hardened. Microscopic sections showed an extensive adenocarcinoma with a somewhat peculiar metastatic spread along the course of the nerve fibers. The lung sections showed metastatic adenocarcinoma. No other metastases were discovered.

The authors comment upon the frequently atypical clinical course of cancer of the pancreas. Only two cases showing metastases to the lungs were discovered in the French literature during the past fifteen years.

One roentgenogram, two photomicrographs

E M SAVIGNAC, M D
Detroit, Mich

Endobronchial Metastases with Symptomatology of Primary Bronchogenic Cancer Roger Even and Jacques Lecœur. *J franç de méd et chir thoraciques* 2: 147-151, 1948 (In French)

Three cases of metastatic cancer of the bronchi are reported. The primary lesion was in the rectum in 2 cases and in the uterus in 1 case. One of the patients had metastatic lesions also in the lung parenchyma, but in the other two the clinical manifestations were those of bronchial obstruction and the tumors could be differentiated from primary bronchogenic carcinoma only by histologic means.

There are two types of bronchial metastases: in one, metastasis is directly to the bronchial wall, in the other, metastatic tumors in the lung parenchyma invade the bronchi secondarily. It is further suggested that certain opacities which are said to represent metastatic tumors *per se* are, in reality, areas of pulmonary infarction, the result of cancer-cell emboli.

The authors stress the importance of a careful systematic investigation in all cases of bronchial obstruction in order to determine whether the cause is a primary neoplasm or a metastatic tumor.

Nine roentgenograms, 2 photomicrographs

RODERICK L TONDREAU, M D
The Mayo Foundation

Secondary Bronchial Cancer with Symptomatology of Primary Bronchial Cancer Lopo de Carvalho, J M Lemone and Y Rose. *J franç de méd et chir thoraciques* 2: 156-160, 1948 (In French)

Seven cases of metastasis to the bronchi are reported

Primary lesions were in the breast (5 cases), uterus (1 case), and testis (1 case). Diagnosis in such cases is not always simple. In certain tracheo-esophageal lesions it is very difficult to determine the point of origin, since both structures have a common embryologic origin. The fact that a secondary tumor has the histologic characteristics of a primary tumor does not necessarily mean that the second tumor represents metastasis for multiple primary lesions may exist. The authors state that in the face of bronchial obstruction metastasis should be especially suspected (1) if the patient is a woman because of the low incidence of primary bronchogenic carcinoma in females, and (2) in all cases in which biopsy reveals adenocarcinoma. Six roentgenograms, 2 photomicrographs.

RODERICK L TONDREAU, M D
The Mayo Foundation

The Pendulum Movement of the Mediastinum in Pneumothorax Lopo de Carvalho, Aires de Sousa and Carlos Vidal J franç de méd et chir thoraciques 2 245-251, 1948 (In French)

Because of contradictory statements in the literature regarding the direction of pendulum movements of the mediastinum in the presence of a pneumothorax, the authors have studied the problem with a special kymograph. This instrument features both horizontal and vertical slits which move simultaneously at right angles to each other, and, when used on the chest, permits a simultaneous study of rib and diaphragm motion on the one hand, and of mediastinal motion on the other. It was found that invariably the mediastinum moves toward the collapsed lung during inspiration and toward the healthy side during expiration. This phenomenon occurred even in the presence of tension pneumothorax with greatly increased intrathoracic pressure. The only exception was in cases of visceroparietal pleural adhesions or other lesions producing fixation of the intrathoracic structures. The mediastinal motion is explained by the altered dynamics in pneumothorax. The increased negative pressure on the collapsed side during inspiration draws the mediastinum over, while on the healthy side the negative pressure increase is neutralized by the entrance of inspired air into the lung. Five roentgenograms, one drawing.

E M SAVIGNAC, M D
Detroit Mich

Dermoid Cysts and Teratomas of the Mediastinum with Unusual Features Herbert C Maier Arch Surg 57 154-161 July 1948

The author reports four cases because of the unusual features of the tumors found. In the first a dermoid cyst of the mediastinum extended from the hilus into the left upper lobe, which was largely replaced by tumor. In the second a teratoma of the mediastinum was discovered in a child of four years and successfully removed. In the third two independent dermoid cysts were present one projecting on either side of the mediastinum. Both were removed but at two operations the fourth case a dermoid cyst with calcification in the walls was not seen to grow over a four-year period, nevertheless, at operation an infiltrating inoperable tumor was found and the patient subsequently died of metastases. Eleven roentgenograms.

LEWIS G JACOBS, M D
Oakland Calif

Incomplete Division of the Atrioventricular Canal with Patent Interatrial Foramen Primum (Persistent Common Atrioventricular Ostium) Report of Five Cases and Review of the Literature H Milton Rogers and Jesse E Edwards Am Heart J 36 28-54, July 1948

The authors report 5 cases of their own and give the essential pathological and clinical features in an additional 50 cases, reported in the literature of the congenital anomaly characterized by incomplete division of the auriculoventricular canal. In 3 of the authors' cases the essential anomalies were virtually identical, consisting of a defect in the lower portion of the interauricular septum, a defect in the superior and posterior portion of the interventricular septum, and a single auriculo-ventricular canal guarded by one valve, which was common to both sides. The essential anomalies in the other 2 cases were a defect in the lower portion of the interauricular septum and a cleft in the anterior or aortic cusp of the mitral valve. The tissue of the aortic cusp of the mitral valve and that of the septal cusp of the tricuspid valve were continuous beneath the defect in the interauricular septum. In one of these latter cases there was a second interatrial septal defect representing a widely patent foramen ovale.

In more than half of the 55 cases death occurred before the age of one year. Only 5 patients lived beyond thirty years. The lesion acts as a simple interauricular septal defect. Secondary changes are right heart enlargement and widening of the pulmonary artery orifice. Cyanosis may be present at birth, but is usually acquired. Cardiac murmurs are frequently observed. A description of the development of the cardiac anomalies is included. Data for the 55 cases are tabulated and references are appended. Seventeen illustrations, including 3 roentgenograms, 2 tables.

HENRY K TAYLOR, M D
New York N Y

THE DIGESTIVE SYSTEM

Relaxation of the Gastric Mucosa Producing Pyloric Obstruction. Alfred Zacho Arch Surg 57 45-50, July 1948

The presence of abnormally lax, redundant, and loosely attached mucous membrane in the pyloric region of the stomach may lead to obstructive symptoms either as a result of actual prolapse through the pylorus or by the formation of a valve like fold over the pyloric orifice. A case of each type is reported with operative findings. Clinically the patients had increasing attacks of severe cramping epigastric pain sometimes relieved by vomiting, and loss of weight. The roentgen findings in both cases suggested the presence of a tumor. Resection of the pyloric portion of the stomach led to a cure and the resected specimens showed the marked laxness of the mucosa without other lesion. One roentgenogram, 2 photographs.

LEWIS G JACOBS, M D
Oakland Calif

Diverticula of the Stomach, Report of 26 New Cases S P Bralow and M A Spellberg Gastroenterology 11 59-82, July 1948

The authors review the literature and present a study of 26 additional cases of true diverticula of the stomach.

and 4 cases of false or acquired diverticula. The reported incidence of gastric diverticula is from 0.02 to 2.6 per cent. There is a broad peak age incidence at thirty to fifty years. The posterior wall of the lesser curvature is the most common location. The range in size is considerable. The sac may contract after surgery so that it is much smaller than it appears, when distended by barium on the roentgenogram. In one of the authors' cases the surgical specimen measured 7×4 cm though roentgenographically the diverticulum was so large as to be mistaken for a cascade stomach.

The signs and symptoms are not characteristic and diagnosis is usually made by roentgenography or gastroscopy. The radiologic diagnosis is based on retention of the opaque medium in the diverticular sac after the remainder of the stomach has emptied. The diagnostic requirements as laid down by other writers are (1) a mobile sac not attached to extragastric tissues, (2) a well defined smooth shadow observed from various angles, (3) generally absence of tenderness, (4) demonstration of rugae in the mucosal lining of the neck, (5) location on the lesser curvature of the posterior wall of the cardia, (6) in some cases ability to empty the sac by change of position.

Gastroscopy is of especial importance for ruling out other conditions as gastric ulcer since the appearance is quite characteristic. In 2 cases seen by the authors a lesion diagnosed radiologically as a diverticulum was shown gastroscopically actually to be an ulcer. In one case with negative roentgenograms gastroscopy revealed a diverticular ostium but in 2 instances a diverticulum demonstrated radiologically was missed probably because of its location.

Associated gastro-intestinal disease is frequent, and the mere presence of a diverticulum should not be accepted as the sole factor responsible for symptoms. On the other hand, the condition may produce pain, vomiting and hemorrhage of incapacitating character.

Thirteen illustrations including 10 roentgenograms

J. D. CALHOUN, M.D.
University of Arkansas

Cavernous Angioma of the Stomach. Rosario Impallomeni and Aldo Greco. *Radiol. med.* (Milan) 34: 343-348, June 1948. (In Italian.)

The authors describe a case of cavernous angioma (proved at operation) involving the upper portion of the greater curvature of the stomach. The radiologic appearance was that of a flat filling defect without obliteration of the mucosal folds. The clinical complaint was pain following meals. No gross or occult blood was found.

Three roentgenograms

CESARE GIANTURCO, M.D.
Urbana, Ill.

Leiomyosarcoma of the Stomach. Review of Sixteen Cases and a Report of a Case of Multiple Leiomyosarcomas of the Stomach. Charles P. Marvin and Waltman Walters. *Arch. Surg.* 57: 62-70, July 1948.

Leiomyosarcoma is the rarest of the gastric sarcomas constituting about 10 per cent of the total. The records of the Mayo Clinic from 1907 through 1946 contained 16 cases, during the same period 10,000 surgically verified cases of gastric carcinoma were seen. The tumor has no sex predilection and may occur at any age, the average being about forty-five years. Sym-

toms are not specific and often resemble the ulcer syndrome. The most characteristic syndrome is hemorrhage, pain in the left upper quadrant or epigastrium and an upper abdominal mass. Achlorhydria was present in 3 of the 11 patients subjected to gastric analysis. The roentgen picture is also not characteristic, often leading to a diagnosis of carcinoma. Schindler and his co-authors believed a gastric filling defect with a central niche and fistulas to be suggestive of the diagnosis, but this was not true of the series of cases here studied, only 1 of which showed this triad on dissection.

The tumors varied from Grade I to Grade III (Broders); in only two were the adjacent nodes involved. Distribution in the stomach was random, all portions being affected. Ulceration was present in 8 cases.

Treatment is surgical. Ten of the authors' patients had subtotal gastrectomy, 1 had total gastrectomy and 5 had transgastric local excision. Of 15 patients traced, 6 are alive for periods varying from three months to seven years, 2 died postoperatively and 7 died at various periods up to four years. The prognosis seems a little more favorable than in gastric carcinoma.

In a detailed case report on one of these patients, the authors describe the presence of multiple and apparently independent leiomyosarcomas.

Two tables
LEWIS G. JACOBS, M.D.
Oakland, Calif.

A Study on the Occurrence of Pneumoperitoneum after Gastroscopy and the Observance of Interstitial Emphysema of the Stomach. James Myhre and J. Allen Wilson. *Gastroenterology* 11: 115-119, July 1948.

Having found in the literature 13 cases of pneumoperitoneum following gastroscopy, the authors made a study of 119 consecutive gastroscopic examinees with this eventuality in mind. In each instance an upright x-ray film of the abdomen was made twenty-four hours after the procedure. In none of these was a pneumoperitoneum found, but in 2 cases the roentgenogram showed a thin line of decreased density, presumably air in the left upper quadrant of the abdomen closely approximating but separate from the air bubble in the stomach. This was diagnosed as interstitial emphysema of the stomach. The second case was followed serially and the density disappeared in seventy-two hours. Both patients were asymptomatic.

Previous reports comment on the lack of evidence to suggest perforation of the stomach wall by the gastro-scope. The authors feel that a perforation is probably not necessary but that interstitial emphysema is one of the steps in progression to gross leakage into the peritoneal cavity.

Three roentgenograms

[In this same issue of *Gastroenterology* (pp. 127-129) there appears a report, by Lichstein and Wharton, of a case of pneumoperitoneum following gastroscopy in which no perforation could be found at laparotomy three hours later.—Ed.]
GEORGE REGNIER, M.D.
University of Arkansas

Multiple Duplicative Cysts of the Duodenum Causing Acute Intestinal Obstruction in a Girl Five and One-Half Years of Age. N. Frederick Hicken, Vernon L. Stevenson, John H. Carlquist, and Q. B. Coray. *Am. J. Surg.* 76: 92-98, July 1948.

The authors report the occurrence of two duplicative

cysts of the duodenum, producing a compressive obstruction of the descending and transverse segments, in a child of five and a half years

Congenital duplications may occur in any portion of the alimentary tract. If the mucosal component becomes active, the retained secretions may produce a cystic tumefaction which by extrinsic pressure obstructs the parent structure. The duodenum is seldom affected by these congenital duplications, only 9 cases appearing in the literature. None of these was recognized before surgical intervention or postmortem examination. The authors' case was considered on roentgen examination to be one of retroperitoneal tumors. Only at operation was its true nature recognized.

The authors make the point that roentgenologic studies afford the only method of making an accurate preoperative diagnosis. The scout films usually localize the obstruction in the duodenum by outlining the distended, gas-filled stomach, while the small intestines and colon harbor but little gas. Peristaltic waves are seen to originate in the stomach and end abruptly at the obstruction. Fluoroscopy is particularly informative, as the ingested barium can be seen to traverse the attenuated but displaced duodenum. As the cyst lies in the gastroduodenal ligament, it pushes the duodenum upward and outward, thereby widening the U-shaped appearance of the duodenal loop. The fact that the tumor is periduodenal immediately precludes the possibility of a hypertrophied pyloric ring. Duodenal diverticula may occupy the same position but always communicate with the intestinal lumen and hence become filled with the contrast medium. Partial atresia results in a narrowed duodenal lumen which occupies a normal anatomic position and is not rotated, compressed, or dislocated by adjacent tumefactions.

Remedial surgery affords the only opportunity for survival. Some cases may be suitable for local resection, but in the majority a posterior gastrojejunostomy must be done in addition.

Four illustrations, including 2 roentgenograms, 1 table

MARLYN W. MILLER, M.D.
University of Pennsylvania

Gallstone Ileus Associated with Diverticulitis of the Colon. A Case Report. Irving I. Lomhoff and Jerome Dubow. *Am J Roentgenol* 60: 86-89, July 1948.

The authors present a case of gallstone ileus with an associated diverticulitis. The 71 year old patient was treated conservatively and recovered. She was dismissed from the hospital with the diagnosis of intestinal obstruction due to diverticulitis and passed the large gallstone at home. In retrospect the gallstone was identified in the barium enema study.

The incidence of gallstone ileus is low (0.4 to 5.0 per cent of all intestinal obstruction). Its importance lies in its high mortality, about 50 per cent. In the large majority of cases the stone becomes lodged in the small intestine. In a series of 125 cases reported by Foss and Summers (*Ann Surg* 115: 721, 1942; *Abst in Radiology* 39: 751, 1942), only 3.3 per cent involved the large bowel.

The importance of considering gallstone impaction in the differential diagnosis of intestinal obstruction is stressed, especially if one is dealing with elderly females with a history of gallbladder disease.

Five roentgenograms

JAMES C. KATTERJOHN, M.D.
Indianapolis, Ind

Chronic Relapsing Pancreatitis. An Analysis of 27 Cases Associated with Disease of the Biliary Tract. Earl E. Gambill, Manfred W. Comfort, and Archie H. Baggenstoss. *Gastroenterology* 11: 1-33, July 1948.

Chronic relapsing pancreatitis typically manifests itself by recurring attacks of pain in the upper part of the abdomen, by disturbances of function of acinar and islet cells, and by certain sequelae. It is a distinct clinical entity and does not require the presence of disease of the biliary or gastro-intestinal tract for its inception or continuation. Biliary tract disease is present, however, in many cases.

The authors present an analysis of 27 cases of the condition associated with biliary tract disease encountered in the Mayo Clinic in the years 1939-43, and compare their findings with those in a series of 29 cases without associated biliary tract involvement done during the same period.

Several interesting observations are made. In the group with associated biliary tract disease about 25 per cent of the patients gave a history of heavy use of alcohol. An acute and painful seizure usually marked the onset of the disease and was the most violent manifestation, but the character of the pain varied. Pain frequency and severity usually increased. About 10 per cent of the patients had glycosuria. In only 3 of the 10 cases in which the fasting concentration of blood sugar was determined was it greater than 120 mg per 100 c.c. A preoperative diagnosis of chronic pancreatitis was infrequent.

Cholecystography was done in only 3 of the 10 cases in which the gallbladder was present at the time of examination. Gallbladder function was shown to be normal in one, poor in a second, and absent in the third. A roentgenogram of the gallbladder region, made in 6 cases, showed pancreatic calculi in 1. Films of the pancreatic region, made in 7 cases, disclosed calcification in 5. In order to exclude a renal origin for the painful seizures, excretory urography was done and served to reveal pancreatic calcification in 1 instance. Roentgenograms of the colon were normal in 5 cases, excluding it as the source of the trouble.

The clinical picture of the disease is apparently fairly constant regardless of the presence or absence of disease of the biliary tract, but the superimposition of the latter adds to the diagnostic problems. Correct diagnosis depends upon a high index of suspicion, roentgenologic findings, and pancreatic function tests.

Evidence is cited supporting the thesis that in chronic relapsing pancreatitis, disease of the biliary tract may be secondary to the pancreatic disease.

Nine photomicrographs
J. D. CALHOUN, M.D.
University of Arkansas

THE MUSCULOSKELETAL SYSTEM

Eosinophilic Granuloma of Bone. Report of Six Cases. Joseph L. Platt and Richard B. Eisenberg. *J Bone & Joint Surg* 30A: 761-768, July 1948.

This is a report of five cases in outline and one in detail of eosinophilic granuloma of bone. The patient whose history is given in detail was a white male, 14 years of age, who in January 1945 showed small irregular and confluent cystic areas in the neck and intertrochanteric region of the right femur. There was slight cortical thickening, suggesting periosteal reaction. Four months later, scattered osteolytic areas were seen in the left frontal bone, and one year later,

the lesion in the right femur showed considerable regression. A year and four months after first observation, a similar lesion developed in the right mandible at the angle. A biopsy showed eosinophilic granuloma. Irradiation therapy was administered to the various lesions, with prompt regression. One of the other cases also showed a similar response to irradiation therapy. Since these lesions are known to regress spontaneously, however, no definite claim for complete dependence on irradiation is made.

Eleven illustrations including 7 roentgenograms, 1 table
JOHN B. MCANENY, M.D.
Johnstown, Penna.

Eosinophilic Granuloma of Bone with Diffuse Pulmonary Involvement. Douglas D. Dickson. *California Med.* 69: 51-53, July 1948.

A case of eosinophilic granuloma of bone is reported with lesions involving the acromion, sacrum, ischium, greater trochanter, and vertebrae. Associated with these there was a diffuse nodular infiltration of both lung fields demonstrable roentgenographically. Bone biopsy revealed eosinophilic granuloma. X-ray therapy to the bone lesions produced a definite improvement, but the pulmonary lesions showed no response.

Four roentgenograms, 1 photomicrograph
MAURICE D. SACHS, M.D.
Cleveland, Ohio

Solitary (Unicameral) Bone Cyst. Arthur G. James, Bradley L. Coley, and Norman L. Higinbotham. *Arch. Surg.* 57: 137-147, July 1948.

This report deals with 26 cases of solitary bone cyst seen in the period 1933-46, and comparison is made with a group of the same number of cases seen from 1920 to 1933. This lesion is relatively rare, occurring in childhood and adolescence in the proximal ends of long bones, especially the humerus and femur. Physical findings are meager and non-specific; the roentgenogram shows a solitary area of bone destruction on the diaphyseal side of the epiphyseal line, circumscribed and surrounded by the expanded and attenuated cortex. Fine trabeculae often traverse the area; they are caused by ridges on the cyst wall. Several theories have been advanced as to the cause of these cysts, but none is entirely satisfactory.

Treatment is surgical. In 11 cases of the present series a simple curettage was done, and in 14 curettage plus bone transplantation. One patient was not treated. Four recurrences, 2 single and 2 repeated, were treated by reoperation, 1 required resection and segmental graft. Cavities are filled in with bone chips from the tibia or iliac crest. Radiation therapy is not recommended because of the unavoidable exposure of the epiphyseal plate, leading to growth disturbances. No example of sarcomatous degeneration was seen following surgery.

Six roentgenograms
LEWIS G. JACOBS, M.D.
Oakland, Calif.

X-Ray Diagnosis and Therapy in Arthritis. M. F. Godfrey. *California Med.* 69: 16-18, July 1948.

Four types of arthritis are commonly observed by the clinician: (1) osteoarthritis (degenerative or hypertrophic type), (2) rheumatoid arthritis (atrophic or proliferative), gouty arthritis, non-articular or soft-tissue rheumatism.

In osteoarthritis involving the interphalangeal joints

the roentgenogram reveals narrowing of the cartilages and a broadening of the articular ends of the bones, which show a tendency toward proliferative changes at the periphery of the articular surfaces. In more advanced stages there may be a 'hill-and-valley' grooving of the badly worn ends of the bones.

In rheumatoid arthritis involving the hands, there is destruction of the cartilages of the proximal joints of the fingers, the metacarpal phalangeal joints, and the carpal regions, with fusiform swelling about the proximal joints of the fingers. The distal joints of the fingers are uninvolved. No new bone is laid down about the joints. If the spine is involved, the extremities are usually spared, and vice versa. In some cases the first evidence of disease in the back is in the sacroiliac joints, manifest roentgenographically as a loss of sharp definition of the outlines of the articular surfaces of one or both joints. Eventually actual bony ankylosis occurs.

Gouty arthritis may show no bone changes roentgenographically even in the late stages. When roentgen signs are present, they consist in definite punched-out areas in the subchondral bone at the heads or bases of the long bones of the hands or feet. Destruction of the articular surfaces of one or many joints may eventually take place.

Non-articular or soft-tissue rheumatism may cause roughening of the periosteum of the long bones and is associated frequently with capsulitis, pericapsulitis, and tendon sheath inflammation.

Roentgen therapy may be given locally over inflamed joints, for relief of pain, in osteoarthritis, rheumatoid arthritis, gouty arthritis, and in cases of capsulitis, pericapsulitis, bursitis, or tendinitis. It appears to relieve muscle spasm as well as to improve circulation and lymphocytic infiltration, but it does not deter degeneration of the joint. The author's technique is briefly as follows: For the elbow, wrist, ankle, shoulder, hip, and knee, the dose is 100 to 150 r per treatment. Treatments are given twice weekly, two ports, anterior and posterior, being employed for the larger joints. Four to eight treatments are given. A second course of four treatments may be given after an interval of six to twelve weeks.

For spondylitis, radiation is given along the entire spine by segments, ports 10 cm. in width being used. Not more than half the spine is irradiated at one sitting. A dose of 75 r is given to each field twice weekly for three weeks. The course may be repeated after suitable intervals, but not more than 1,000 r is given to any one field.

For bursitis four treatments given daily or at two day intervals usually relieve spasm and pain. It is well in these cases to obtain a roentgenogram of the joint before therapy to rule out fracture or metastatic bone lesion.

MAURICE D. SACHS, M.D.
Cleveland, Ohio

Bone and Joint Changes in Hemophilia, with Report of Cases of So-Called Hemophilic Pseudotumor. Ralph K. Gbormley and Reed S. Clegg. *J. Bone & Joint Surg.* 30 A: 589-600, July 1948.

Of 150 patients with hemophilia seen at the Mayo Clinic, 76 were sufficiently severe for definite diagnosis, and of these, 44 or 58 per cent showed pathological changes in the bones and joints. All these patients were males, their average age was 17.3 years. The knee was most frequently involved, followed by the ankle, elbow, hip, wrist, patella, and phalanx in that order.

Earlier contributions on the subject are reviewed and six case reports are added to the literature. These six patients presented pseudotumors which seemed to be the result of hemorrhage into the soft tissue with subsequent erosion and destruction of the underlying bone, sinus formation, secondary infection, and terminal hemorrhage or infection.

No definite description of the bone lesions is given, possibly due to the lack of uniformity of the process. The authors state that it is difficult in a given case to determine whether the hematoma extends from hemorrhage in a neighboring joint or whether the hemorrhage is subperiosteal or intramedullary in origin.

Twenty illustrations, including 13 roentgenograms, 2 tables

JOHN B. McANENY, M.D.
Johnstown, Penna.

Aseptic Necrosis in Gaucher's Disease Alvin M. Arkin and Albert J. Schein. *J. Bone & Joint Surg.* 30 A 631-641, July 1948.

The purpose of this paper is to draw attention to the observation that aseptic necrosis of bone is a very significant factor in Gaucher's disease of bone.

Six case reports and the corresponding roentgenograms are presented, showing the involvement of the femoral capital epiphysis, with changes similar to Legg-Perthes disease, in patients who were known to have Gaucher's disease. Some of these patients also present dense linear markings in the bone structure, similar to that seen in caisson disease.

The characteristic bone lesion of Gaucher's disease is a radiolucent and rarefied area of bone, due to infiltration of Gaucher cells. The increased density in the bone as here presented is believed due to the infiltration of the cells around the small arteries and capillaries, sufficient to cut off circulation and produce aseptic necrosis.

Seventeen roentgenograms

JOHN B. McANENY, M.D.
Johnstown, Penna.

Coexisting Multiple Myeloma and Paget's Disease of Bone Treated with Stilbamidine Carl Reich and Alexander E. Brodsky. *J. Bone & Joint Surg.* 30A 642-646, July 1948.

A 52 year-old white male had been treated for four years for pain in the back and hips. Roentgen examination showed diffuse osteoporosis of the thoracolumbar spine with ballooning of the intervertebral disks and wedging and compression of the fourth, sixth, seventh, and eighth thoracic vertebrae. The upper portion of the left femur showed characteristic Paget's disease of the bone, the upper right femur, moderately large decalcified areas without adjacent sclerosis. The upper portions of both humeri and the ribs showed punctate decalcification. Urine examination for Bence Jones protein was negative. In spite of this latter observation the possibility of multiple myeloma was considered, and further laboratory tests were undertaken, showing hyperglobulinemia with high total serum protein and serum globulin. Sternal puncture definitely established a diagnosis of multiple myeloma.

This is believed to be the first reported case of Paget's disease complicated by multiple myeloma of the bone. The suggestion is offered that this combination may be more frequent than is realized and that, in the presence of decalcification accompanying Paget's disease, bone marrow study should be performed.

The authors discuss the use of stilbamidine to relieve the pain and discomfort of the multiple myeloma. In this case definite relief was obtained and the patient returned to gainful occupation. No curative effect of the drug has been claimed.

Two roentgenograms, 1 photomicrograph

JOHN B. McANENY, M.D.
Johnstown, Penna.

Fracture-Dislocation of the Hip Joint: Nature of the Traumatic Lesion, Treatment, Late Complications, and End Results Marshall E. Urist. *J. Bone & Joint Surg.* 30A 699-727, July 1948.

This is the third, and last, of a series on injuries of the hip (for the others see *Am. J. Surg.* 74 586, 1947, and *Ann. Surg.* 127 1150, 1948; *Absts. in Radiology* 51 442, 1948, and 52 765, 1949). It reports 27 cases of hip dislocation associated with major fractures of the acetabulum or femoral head. These include 15 cases of posterior dislocation with fracture of the posterior rim of the acetabulum, 8 fracture dislocations irreducible by closed manipulation, and 4 instances of posterior dislocation with fracture of the head of the femur.

The nature of the injury to the joint was studied in 15 cases treated by open operation. The major damage was sustained by the acetabulum, the periarticular ligaments, tendons, muscles, the ligamentum teres, and the retinacula of the joint. The extent of injury to the acetabulum varied from small chip fractures to involvement of a large segment of the acetabular rim. It was observed that small fragments could come to rest between the articular surfaces and injure them, while large fragments were usually displaced and on replacement would, as a rule, survive. The major damage to the soft parts of the joint was usually sustained by the external portion of the capsule. There was almost always some damage to the femoral head, with separation of the head or a circular depression, either of which may be overlooked on the roentgenogram. The ligamentum teres could not always be inspected in these studies but was found to be stretched and frayed in some instances. Blood clot and organized hemorrhage were seen in the retinacula in two cases. The significance of this finding was not noted until later, when both patients showed aseptic necrosis of the femoral head. The retinacula, three flattened bands of loose fibrous connective tissue containing blood vessels, lie partly within and partly outside the reflected capsule on the inferior, postero-inferior, and posterosuperior aspects of the joint. They carry the blood supply to the femoral head from branches of the medial femoral circumflex vessels. Their role in aseptic necrosis of the hip deserves further study.

In the 15 cases with fracture of the rim of the acetabulum, the diagnosis of fracture was not recorded in about 25 per cent, and in several other cases extensive fractures were not appreciated by the surgeons who administered emergency treatment and manipulated the dislocation. The oversight is easily understood. Unless one knows intimately the roentgen appearance of the hip joint the fracture may seem to be obscured by the head of the femur in films taken before reduction. In cases in which the fracture was finally noted in the post reduction films a false idea of the apposition of the fracture lines was sometimes conveyed by examination of only the anteroposterior view of the hip. A true picture of the displacement of the rim fragments is best obtained in a postero-oblique view, with the injured side

elevated 60 degrees, the patient lying supine on the cassette, thus placing the posterior portion of the acetabulum in profile

In the 8 cases in which the dislocated hip could not be reduced by closed manipulation the difficulty was due either to a comminuted fracture of the acetabulum with intra articular displacement of fragments or to extensive fracture of the entire acetabulum with disorganization of the joint cavity. Stereoscopic roentgenograms were useful in demonstrating the bone fragments and distortion of the joint cavity in these cases.

Gross fractures of the head of the femur are considered rare in dislocation of the hip. As stated above, there were but 4 cases in this series.

Among the complications of fracture dislocations of the hip retroperitoneal hemorrhage may occur in comminuted fractures of the acetabulum where the blood is extruded internally beneath the parietal peritoneum. Distention, vomiting, and fever following the injury should lead one to suspect this condition.

Irritation, obstruction, or laceration of the urethra occurred in several cases in this series and thrombophlebitis was seen once. Thrombosis of the hemorrhoidal veins may occur. Sciatic neuritis occurred, possibly from stretching or irritation of the nerve by the acetabular fragment or the femoral head. Sciatic nerve injury is quite a potentiality, the peroneal portion of this nerve being apparently more susceptible to injury than any other. When there is an indication of sciatic nerve injury with dislocation and fracture, it is thought that open reduction should be resorted to.

Avascular necrosis of the head of the femur was seen in two patients. A review of the operative notes on these patients suggests that this complication is associated with thrombosis of either the retinaculum or the intertrochanteric branches of the medial femoral circumflex vessels. The change occurs between six and eighteen months after injury and the absence of weight-bearing does not seem to prevent injury to the femoral head.

Traumatic arthritis developed in 12 cases within a period of two years after injury. There were irregularities in the articular surface opposite the defect on the injured side of the joint. Eventual loss of joint space occurred in several patients.

The treatment of fracture dislocation of the hip is thoroughly considered.

Thirty-nine illustrations, including 31 roentgenograms, 4 tables
JOHN B McANENY, M D
Johnstown, Penna

Coxa Plana M Beckett Howorth J Bone & Joint Surg 30A 601-620, July 1948

Coxa plana, known also as Legg-Perthes disease, Calvé's disease, osteochondritis deformans juvenilis, and (though inaccurately) as aseptic necrosis of the upper femoral epiphysis, is more common in boys than in girls and in about 90 per cent of the cases is unilateral. The disease is fundamentally a vascular disturbance, followed by degenerative changes in the femoral head. The soft tissues about the joint become swollen, edematous and hyperemic especially the synovial membrane. Perivascular lymphocytic and plasma-cell infiltration are commonly found. There is softening of the diaphyseal side of the disk with decalcification. Later there are absorption and reformation of bone. The capital epiphysis is deformed and there is subluxation of the hip followed by deformity of the acetabular surface.

In the first stages of the disease, lasting several weeks, there is only soft-tissue change with synovitis. Next comes the degenerative or active stage, lasting two years. This is followed by the healing stage, extending over three or four years, and finally the residual stage, with deformity.

The most common symptom is a slight limp with pain referred to the groin and the middle aspect of the thigh or the knee, made worse with use. The symptoms usually increase in severity with the advance of the disease until the end stage, when the disability is due to faulty mechanics.

Roentgenographically, the first change noticed is a globular swelling of the capsule with subluxation of the femoral head laterally. There is no change in the shape of the articular cartilage as yet. Later on there is decalcification on the diaphyseal side of the epiphysis followed by a dense irregular area in the capital epiphysis. The head subsequently becomes decalcified and flattened. The neck becomes thicker and shorter. Still later, the decalcified areas become recalcified and the trabeculation reappears, but the head is flattened and remains subluxated. In middle life osteo-arthritis changes often develop, due to faulty mechanics.

The treatment consists essentially in prolonged rest of the affected joint but numerous operative procedures have been used of late.

Fifty roentgenograms, 4 photomicrographs
JOHN B McANENY, M D
Johnstown, Penna

Laminagraphy Through Plaster Casts in Postreduction Roentgenography of Congenitally Dislocated Hips Bernard S Epstein J Bone & Joint Surg 30A 778-780, July 1948

This short presentation suggests the use of laminagraphy to determine the exact status of bone structures in patients being treated for congenital dislocation of the hip, who are fixed in plaster. The authors use a Kieffer laminagraph with a spiral motion, 150 ma-seconds, 55 to 60 kv, 30 inches distance and par-speed screens. This procedure is said to define the bone structures better than the usual procedure of over-exposed Bucky films and to give more information as to the status of the bone structure.

Two roentgenograms
JOHN B McANENY, M D
Johnstown, Penna

Fractures of the Talus Barnard Kleiger J Bone & Joint Surg 30A 735-744, July 1948

This is a review of 29 cases of fresh fracture of the talus. In 11 simple linear fractures through the body, close to its juncture with the neck, the results were uniformly good with immobilization. In 2 cases complicated by additional fractures the outcome was not as good.

The medial articular surface was fractured once, the lateral articular surface five times, and the posterior tubercle twice in this series. If these fractures were uncomplicated by other injuries, the result was good. Where a fragment of bone is displaced from the superior articular surfaces, the prognosis is not necessarily poor, if the fragment can be manipulated into its proper position. It is believed that fractures of the articular surface should be reduced either by closed reduction or by operation and the fragment left in place in which case adequate healing usually occurs.

In 8 patients, the fracture was through the body near its juncture with the neck, with displacement. If the displaced fragment could be reduced accurately, union usually took place. The only exception was when the proximal fragment was displaced posteriorly, tearing the ligaments and depriving the capital fragment of its normal blood supply. In these cases, the result was always bad and aseptic necrosis was likely to develop. It was thought that arthrodesis of the ankle joint might well have been done as a primary procedure in these latter conditions.

Thirty-three roentgenograms

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Myxochondrosarcoma of the Talus. H. Paul Longstreth, Pio Blanco, and Samuel Sanes. *J. Bone & Joint Surg.* 30A: 774-778, July 1948.

This is a detailed case report of a 62-year-old white male who had a minor injury to his right ankle, followed by limitation of motion and tumor formation along the dorsum of the foot over the talus. Roentgen examination showed destruction of the superior border of the talus with invasion of the overlying soft tissue. A biopsy was done, establishing the diagnosis of chondrosarcoma. Roentgen therapy was administered for a total of 5,700 r to the right foot, in two courses. About one year later, examination showed no essential change in the bone. The patient then submitted to amputation of the lower right leg. Examination of the amputated member showed a definite myxochondrosarcoma. Five months later, an area of increased density was apparent in the right apical region of the chest, accompanied by cavity formation. Tuberculosis was suspected, but apparently not metastasis. Shortly afterward, the patient committed suicide. Autopsy showed metastatic myxochondrosarcoma in the right lung.

This is the eleventh case of myxochondrosarcoma of the talus to be reported. The age is between eleven and sixty-two years, with 8 male patients and 3 females. No definite relationship between injury and tumor formation has been established. Amputation is thought to be the best treatment. The differential diagnosis between myxochondrosarcoma and osteogenic sarcoma, myeloid sarcoma, giant-cell tumor, and fusiform-cell sarcoma must be made. Chondrosarcoma grows slowly, as shown in the present case report, in which there was a lapse of three and one-half years from the onset of symptoms to the time of death.

Six illustrations including 1 roentgenogram

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Bilateral Osteochondritis of the Tarsal Navicular and the First Cuneiform. A Case Report. Arch F. O'Donoghue, Edmund S. Donohue, and Wayne W. Zimmerman. *J. Bone & Joint Surg.* 30A: 780-781, July 1948.

While osteochondritis has been found in most of the bones of the body, bilateral involvement of the tarsal navicular and first cuneiform has seldom been recorded. In the case reported here, roentgenographic examination of a three-year-old boy showed that the first cuneiform of each foot had a fragmented, moth-eaten appearance. A year later both tarsal naviculars—not yet completely ossified—showed evidence of fragmentation. Treatment was by supportive plates.

Two roentgenograms

THE GENITO-URINARY SYSTEM

Value of Urography in Elucidation of Nonurologic Complaints. Allan K. Swersie. *New York State J. Med.* 48: 1607-1609, July 15, 1948.

Gastro intestinal symptoms are often prominent in disease of the upper urinary tract. Because of this, urographic studies should be done if gastro intestinal films show nothing to account for such complaints. Two examples illustrate this point. In one case "gall-bladder symptoms" proved to be the result of a mild right hydronephrosis due to constriction at the utero-pelvic junction. The second patient gave a history of epigastric pain attributed to ulcer, in spite of negative x-ray studies. He was found to have a crossed ectopia with probable fusion of the kidneys. Following passage of a calculus he was relieved of all complaints.

A third patient had urinary complaints and urography showed an extrinsic mass exerting pressure on the bladder. This proved to be an ovarian cyst. This case is thus the exact opposite of the others, an example of non-urologic disease producing urologic findings.

Three roentgenograms ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pyelography as an Aid to the Differential Diagnosis of Upper Abdominal Masses. Charles Eberhart and Donald E. Beard. *J. M. Assoc. Georgia.* 37: 265-269, July 1948.

Routine retrograde and intravenous pyelography are useful aids in the diagnosis of upper abdominal masses. The authors stress, in particular, the value of lateral and respiratory pyelography.

The lateral pyelogram made with the affected side toward the film under normal conditions discloses the renal pelvis and calices superimposed on the bodies of the 12th thoracic and 1st and 2nd lumbar vertebrae. The kidney occupies a vertical position. In the presence of renal, extraperitoneal, and intraperitoneal masses, the kidney may be displaced or rotated to the point of diagnostic importance. Differentiation of pelvic renal calculi, parenchymal calcification, gallstones, and stones in the common duct may be made with this technique. The lateral projection is also useful in the diagnosis of renal tumors and cysts, primary retroperitoneal tumors, and retroperitoneal infection. Retroperitoneal tumors may produce torsion but never cause deformity of the caliceal structures. If the kidney is rotated on two or more axes the lesion is likely to be intrarenal. Metastatic disease and tumors and cysts of the pancreas also rotate or displace the kidneys.

Respiratory pyelography is employed most advantageously in the diagnosis of perirenal disease. Fixation of a kidney may, however, be more apparent than real when the diaphragm is fixed by subphrenic disease.

The text of this paper is largely a review of the literature. The authors' own experience is presented in the form of roentgenograms with brief case histories.

Eight roentgenograms LOUIS BERNSTEIN, M.D.
Hartford, Conn.

Roentgen Diagnosis of Tumors of the Urinary Tract. Paul C. Swenson, and Francis F. Hart. *Pennsylvania M. J.* 51: 1114-1121, July 1948.

The purpose of this paper, as stated by the authors, is to correlate the gross pathologic changes found in

urinary tract tumors with the findings on x-ray examination. Plain films of the genito urinary tract, intravenous pyelograms, and retrograde pyelography are employed in diagnosis. For excretory urograms 20 c.c. of diodrast or of neopax is routinely given. The patient is questioned as to a history of allergy and the first cubic centimeter is administered very slowly. Adrenalin is kept ready for immediate use at all times. For retrograde pyelograms 15 per cent skiodan is used.

Simple cysts rarely deform the calices unless they are very large. They are unilateral and appear as a homogeneous soft tissue shadow with a smooth outline.

In polycystic disease the kidneys appear to be normal until the cysts become large. The affection is both congenital and familial and the family history, together with bilateral deformities, should suggest the diagnosis.

Benign and malignant tumors of the parenchyma in the adult cannot be differentiated radiographically. One usually sees a rather huge mass deforming the upper or lower pole of the kidney with the classical symptoms of pain and hematuria. One third of all renal tumors show calcific deposits on x-ray examination. This finding is misleading, however, because there are so many other causes of calcification. Hemorrhage into the kidney pelvis with a resultant clot will produce bizarre pictures on both intravenous and retrograde urography, and a tumor which has become so large that it displaces or rotates the kidney, usually elongates the calices and deforms the pelvis to further distort the x-ray findings.

Benign and malignant tumors of the renal pelvis cannot be differentiated by x-ray. The papillomas and papillary endotheliomas deform the renal pelvis by their growth. The alveolar carcinomas and squamous cell carcinomas infiltrate and cause little deformity. They metastasize early to almost every organ.

Wilms' tumor comprises 20 per cent of all malignant tumors in children. It is almost always evident clinically by the presence of a painless mass in the upper abdomen in the young child. A pyelogram will show a shift of the kidney and deformity of the pelvis due to pressure.

Primary tumors of the ureters are rare, but secondary tumors, as a result of seeding from papillary tumors of the renal pelvis, are comparatively common. The diagnosis of these tumors is difficult because such conditions as ureteritis cystica, hydronephrosis, pyonephrosis, and blood clots deform the ureters and produce a similar picture.

Bladder tumors are sometimes found in double contrast examinations or in cystograms, but can usually be better visualized by cystoscopy.

Seven roentgenograms. JOSEPH T. DANZER, M.D.
Oil City, Penna.

Roentgen Diagnosis of Diffuse Leukemic Infiltration of the Kidneys in Children. John F. Gowdey and Edward B. D. Neuhauser. *Am J Roentgenol* 60: 13-21, July 1948.

Infiltration of the kidneys is frequently found post-mortem in patients dying of leukemia (63 per cent of 123 cases reported by Kirschbaum and Preuss. *Arch Int Med* 71: 777, 1943). When leukemic kidneys are studied by excretory urography the roentgen appearance is characteristic but may be confused with that produced by polycystic kidneys. There may be extreme enlargement of the kidneys with elongation of the renal pelvis, infundibula and calices. Function is

usually well preserved, and there are no rounded pressure defects. Three case reports are included, with accompanying roentgenograms and photomicrographs. In Case III, one of the kidneys infiltrated with leukemic deposits was given roentgen therapy and the opposite kidney used as a control. The kidneys were then checked by excretory urography. The treated kidney showed reduction in size five days after irradiation, evidently due to destruction of radiosensitive leukemic cells. It is suggested that when renal enlargement is detected roentgenographically by excretory urography, the diagnosis of leukemia may sometimes be inferred.

Five roentgenograms, 4 photomicrographs, 1 photograph.
JAMES C. KATTERJOHN, M.D.
Indianapolis, Ind.

Diagnosis and Management of Ureteral Ectopia. Thomas D. Moore. *J Urol* 60: 50-62, July 1948.

The author reports 5 cases of ureteral ectopia and reviews the symptomatology, diagnosis and treatment, referring to several other cases reported in the literature. In the female, the ectopic ureteral orifice is found in the urethra, the vestibule, the vagina, or the uterus. Since all of these locations are distal to the vesical sphincter, urinary incontinence with constant dribbling is the usual presenting symptom. In the male, however, in whom the ectopic ureteral opening is most often found in a seminal vesicle, ejaculatory duct, or the posterior urethra, all of which are proximal to the external vesical sphincter, urinary leakage is not present and the presenting symptom complex is that of unexplained pyuria.

Embryologically, the ureter from the upper segment in renal duplication develops at a later date and is therefore the one usually showing an ectopic orifice. Pathologically, the most frequently encountered type of ureteral ectopia is a complete unilateral duplication of pelvis and ureter with an ectopic opening of the supernumerary ureter. Not infrequently, coexisting anomalies of the genital and urinary tracts are found. The ectopic orifice is often extremely small and difficult to visualize, with diffuse ureterectasis and pyelectasis above the narrowed terminal opening. Because of resulting urostatics, approximately 90 per cent of such cases show evidence of infection. The segment of kidney drained by the aberrant ureter may be hypoplastic or hydronephrotic.

In the author's opinion, intravenous pyelography provides the most important diagnostic aid, especially when the ectopic ureteral opening is demonstrated and can be subsequently catheterized. In retrograde pyelography, however, it must be borne in mind that the lower segment of a duplicated kidney can assume essentially the outline of a normal kidney. Careful inspection of possible sites of the ectopic orifice with a direct vision cystoscope is another important diagnostic procedure. The efficacy of the latter may be augmented by the intravenous administration of indigo carmine, which will subsequently appear at the ectopic orifice.

In treating a case of normally functioning kidney with a single ectopic ureter, it is aimed to conserve the kidney by transplantation of the aberrant ureter to the bladder if the ureterectasis does not contraindicate the procedure. If a marked degree of ureterectasis exists, a complete heminephro-ureterectomy or nephro-ureterectomy may be necessary, since conservative ligation of the ureter results in a high percentage of failures.

Heminephrectomy is the operation of choice in cases of duplication where the blood supply is not intricate, otherwise, complete nephrectomy may be necessary if there is a normal opposite kidney

Six roentgenograms PAUL W. HOFFERT, M.D.
University of Pennsylvania

Recognition and Surgical Correction of Retrocaval Ureter. A Case Report C. D. Creevy J. Urol 60 26-30, July 1948

Thirty-eight cases of retrocaval ureter have been reported in the literature. Approximately half of the cases are asymptomatic and the other half cause symptoms of obstruction and hydronephrosis.

Retrocaval ureter is an anomaly of the venous system in which the vena cava is formed from veins that lie anterior to the ureter in the embryo, and which normally disappear early in the course of development. The ureter thus passes behind the vena cava a short distance below the renal pelvis. Its aberration in course is characteristic and readily identifiable on a pyeloureterogram.

A case is reported with preoperative diagnosis and successful correction.

Four roentgenograms VERN W. RITTER, M.D.
University of Pennsylvania

THE BLOOD VESSELS

Diagnosis and Treatment of Arteriovenous Aneurysms in the Vicinity of the Cerebral Hemispheres G. Weber Schweiz med Wchnschr 78 629-634, July 3, 1948 (In German)

This report covers 15 cases of arteriovenous aneurysm of the cerebrum, all demonstrated by arteriography. This condition is a congenital anomaly rather than a true tumor. Clinically the patients fell into several groups. Four patients had epileptiform seizures, 4 showed the residua of subarachnoid hemorrhage with or without a hemiparesis, 6 had signs of both subarachnoid hemorrhage and epileptiform seizures. One patient, a girl of nine, had monthly migraine accompanied by nausea and vomiting, with a slowly progressive left hemiparesis.

The symptoms of headache, vomiting, and dizziness have been described as typical of intermittent elevation of the intracranial pressure, and in arteriovenous aneurysm they are usually accompanied by jacksonian attacks, and almost always by hemiparesis. In 14 of these patients the symptoms began between the eighth and twenty eighth years, in one the onset was at thirty-six years. Onset in later life, however, is not extremely uncommon. The conclusive proof of the diagnosis in each of the author's patients was obtained by cerebral arteriography, and some fair reproductions of a selection from these arteriograms accompany the paper.

Treatment is of three types, direct exposure with radical extirpation, ligation of the homolateral internal carotid artery, and irradiation. One of the author's patients, was not treated and his subsequent course is not known. One was treated by extirpation, and recovered, but with occasional residual attacks, one had x-ray therapy only (8,000 r), with no relief from his attacks, but no progress of the disease and full working ability. The other 12 had carotid ligation, and in 10 x-ray therapy—from 2,400 to 8,140 r—was given in addition. In only one of these was there a slight and transitory hemiparesis as a result of treatment, and none became unconscious, somnolent, or aphasic. Pre-existing hemiparesis was not greatly changed by the ligation. One patient showed a slight psychogenic injury as a result of this treatment. Of the 12, one died of intercurrent pneumonia after three months, the others showed a lessened tendency to subarachnoid hemorrhage, especially after irradiation, seizures were lessened in number, but the use of phenobarbital makes this finding hard to evaluate.

Of the types of therapy available, extirpation has the advantage of complete cure of the lesion, but the associated damage will be maximum. The combination of ligation and irradiation does not produce as perfect results, but does less damage to the surrounding brain tissues. Individualization of treatment is essential, but the author inclines to favor ligation plus irradiation in most cases.

Four roentgenograms, 1 table

LEWIS G. JACOBS, M.D.
Oakland, Calif

RADIOTHERAPY

Roentgen Treatment for Extensive Epithelioma of the Larynx. Results in 139 Cases Arthur U. Desjardins, Frederick A. Figg and Luther M. Vaughan. Am J Roentgenol 60 29-36 July 1948

'To practice medicine means not only to try to cure patients when this is feasible, but also to relieve suffering in any form when a cure is impossible.' With this premise in mind the authors treated 139 patients with extensive and advanced laryngeal epitheliomata from 1936 through 1945. They used 200-kv roentgen therapy, Thoraeus filter and a target-skin distance of 50 cm. Two portals were employed (one directed to each side of the larynx) except in very large lesions, for which the number was increased to three (two on the most extensively involved side). The patients were treated daily (except Sunday) with 200-400 r to one portal. After trial and error it was found that the optimum dose was 3,500 to 4,000 r to each of two fields. The fields were larger (18 × 12 to 12 × 18 cm) than customarily used by most therapists but they had to be

large to include all of the bulky lesions which were treated.

A very high degree of palliation was obtained in almost all of the cases in this series, and 12 of 71 patients treated up to 1942 were alive for periods of five to eleven years—a five year survival rate (not cure rate) of 17 per cent, despite the fact that all had such advanced disease that surgery was not feasible. In the authors' words 'indeed, a more unfavorable group of cases would be hard to find.'

In discussing this paper, Dr. Douglas Quick states "Such results demand, for irradiation, a trial in the less advanced cases, and for the more favorable and earlier cases they demand at least a consideration of radiation on an equal basis with surgery." Certainly the authors clearly demonstrate by this excellent paper that one cannot discount the importance of irradiation in the management of carcinoma of the larynx.

One table

JAMES C. KATTERJOHN, M.D.
Indianapolis, Ind

Late Results of Radium Therapy for Carcinoma of the Uterine Cervix Harry H. Bowing and Robert E. Fricke. *J A M A* 137:935-941, July 10, 1948

Thirty-two years of experience are reflected in this report of 2246 patients with carcinoma of the cervix treated with radium and roentgen therapy. Various factors are evaluated, such as age, extent of the primary lesion and previous treatment and an attempt to formulate a basis for prognosis is considered. The prognosis for the patient under forty-nine years of age is not as good as that for older patients. The most important factor is the stage of the disease. The more localized it is, the better the prognosis.

The authors justly emphasize the necessity for evaluation of each patient and for close observation and follow-up. Of their patients traced five years after leaving the hospital, 33 per cent were living.

Seven tables
PAUL W. ROMAN, M.D.
Baltimore, Md.

Krukenberg Tumor with Osteoplastic Metastases Joseph H. Zeigerman. *Am J Obst & Gynec* 56:187-190, July 1948

This concise informative article describes a case of ovarian carcinoma with bone metastases of a predominantly osteoplastic nature. Previous reported cases describe the opposite picture of bone pathology, namely, osteoclasia.

A 27-year-old woman complained of vaginal bleeding and of a mass in the abdomen. A salpingo-oophorectomy for a right ovarian tumor had been performed one year previously, but the exact nature of the tumor was not determined. A second operation revealed an ovarian tumor representing mucoid carcinoma of the Krukenberg type. Studies of the gastrointestinal tract were negative. Three courses of irradiation therapy were proposed, but shortly after the first course an x-ray survey of the entire skeleton, prompted by pain in the dorsolumbar spine and the thighs, revealed widespread osteoplasia of varying degrees. The patient died three months after the onset of the metastatic bone symptoms and eight months after the second operation.

No cause for the predominant osteoplasia is given, however, the author considers the possibility of a hormonal relationship, since estrogens may cause a deposition of calcium in the secondary trabeculae of the bone.

Two roentgenograms, 1 photomicrograph
ROBERT H. LEAMING, M.D.
Jefferson Medical College

Wilms' Tumor William J. Daw. *J Urol* 60:18-25, July 1948

The author reviews 7 cases of Wilms' tumor seen at the Wilkes-Barre (Penn.) General Hospital from 1937 to 1945. Of these, 2 were first seen after the development of multiple metastases. In the other 5 cases nephrectomy was done and 3 of the patients have survived six, five and two years, respectively. Of these, 1 had preoperative roentgen therapy and all had post-operative irradiation.

The author feels that early nephrectomy, either transperitoneal or lumbar, followed by adequate roentgen therapy is the treatment of choice.

Eleven illustrations including 3 roentgenograms
JOHN O. LAFFERTY, M.D.
University of Pennsylvania

Treatment of Bladder Tumors Archie L. Dean. *J Urol* 60:92-97, July 1948

The author has analyzed and classified bladder tumors according to the best method of treatment under the following headings: (1) transurethral electrocoagulation, (2) transurethral implantation of radon seeds with or without electrocoagulation, (3) segmental resection of bladder wall, (4) suprapubic cystostomy with implantation of radon seeds with or without electrocoagulation, (5) uretero-intestinal anastomosis with removal of bladder and prostate, (6) cutaneous ureterosomy with removal of bladder and prostate, (7) roentgen therapy.

The therapeutic indications are summarized in seven tables of which those having to do with irradiation are reproduced here, though the article is well worth reading in its entirety.

Transurethral Implantation of Radon Seeds With or Without Electrocoagulation

Single papillomas or single papillary carcinomas

- 1 Favorably situated as regards
 - (a) Complete cystoscopic vision
 - (b) More than 1.5 cm. from ureteral orifice
- 2 Not larger than 2.5 cm. base diameter. No infiltrating tumors.

Suprapubic Cystostomy with Implantation of Radon Seeds With or Without Electrocoagulation

- A Papillomas too large or unfavorably situated for transurethral treatment or segmental resection.
- B Carcinomas (papillary or flat) no larger than 3 cm. in diameter.

Tumors may touch trigone but must be at least 1.5 cm. from urethral orifice. These growths are not resectable and do not infiltrate the prostate.

If radon seeds are placed within 1.5 cm. of a ureteral orifice the ureter should be reimplanted in the bladder.

Roentgen Therapy

- A Contact therapy for conditions better treated with radon seeds or resection.
 - B High voltage and supervoltage (the latter preferable for tumors as deeply situated as those of the bladder).
- For palliation in old, feeble patients with extensive anaplastic tumors and minimal ureteral obstruction.

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Roentgen Therapy of Malignant Tumors of the Testis. Eugene T. Leddy. *Am J Roentgenol* 60:39-44, July 1948

The principles advocated by the author for the treatment of testicular tumors are based upon an experience with at least 500 cases in the past twenty years.

Biopsy should consist of simple orchiectomy without preoperative irradiation. Tissue examination will then reveal one of the following types of lesion: (1) teratoma, (2) adenocarcinoma of the seminoma type, or (3) adenocarcinoma of the testis. Seminomas and teratomas constitute about 95 per cent of the total.

Irradiation of seminomas and their secondary deposits is best carried out with roentgen rays of moderate voltage (130 to 140 kv). Intermediate voltage is used

because treatment must always be extensive, because it is believed that there is no difference in the effectiveness of this type of radiation and that generated at higher levels (200 to 250 kv), and because less harm will be done to the patient if this type of treatment is used. Four anterior abdominal fields and four corresponding posterior fields are treated, the mediastinum and the left supraclavicular space are always treated. Each field receives about 540 r (total dose, in air), two fields are treated daily, depending on the patient's tolerance. A similar course of treatment is again given one month later, and if metastatic deposits have been present in the abdomen before operation, a third course is given after a lapse of two months. The blood count is carefully watched during treatment.

That the methods of treatment employed are satisfactory is confirmed by the statistical study of Cabot and Berkson, who reported a 71 per cent survival for patients with seminomas receiving roentgen therapy and a 58 per cent survival without roentgen therapy [Cabot and Berkson's study (New England J Med 220 192, 1939) Abstr in Radiology 34 259, 1940] was based upon a series of cases seen at the Mayo Clinic up to 1937 and must, therefore, have included a considerable number of the cases upon which the present paper is based. The relation of the results to the extent of the disease is not discussed. In general, however, it was found that for cases with no evidence of abdominal metastases at the time of irradiation the three year survival rate was twice as high as in cases known to have secondary disease in the abdomen.

The symptoms of para aortic lymph node involvement are dull aching pain in the back, bloating, belching, fullness in the abdomen, and constipation. When a definite mass of lymph nodes cannot be palpated in the abdomen, vague resistance to the examiner's hand and tenderness on deep palpation are usually considered suggestive of metastatic disease. Metastases may also be detected by excretory urography and other forms of roentgenography. Following involvement of the para aortic nodes the left supraclavicular lymph nodes are involved, and later the peribronchial nodes.

Since it is well known that seminoma of the testis responds well to roentgen therapy, the therapeutic test can often be used with high accuracy to judge the nature of metastatic lesions when their histopathology is unknown.

Malignant teratomas do not respond very well to roentgen therapy in Leddy's experience. Since some tumors may be an admixture of seminoma and malignant teratoma they may respond initially, but continue to grow after the more sensitive elements have been destroyed.

"For the treatment of seminomas, roentgen therapy has assumed a position of prime importance and has altered the prognosis from one of hopelessness to one of

subdued optimism. This is quite different from the prognosis of malignant teratoma of the testis—no technique of treatment which we have used within the limits of safety has been more than temporarily effective in the treatment of metastatic lesions caused by malignant teratomas." JAMES C. KATTERJOHN, M.D.
Indianapolis, Ind.

Roentgenologic Treatment of Lymph Nodes and Spleen in Brill-Symmers Disease Sidney Rubinfeld J A M A 137 849-852, July 3, 1948

This paper is based upon observations on 9 cases of giant follicular lymphadenopathy (Brill-Symmers disease) and 10 cases of polymorphous-cell sarcoma (of Symmers). Giant follicular lymphadenopathy may remain unchanged throughout life, it may undergo transformation into lymphosarcoma, lymphoid leukemia, Hodgkin's disease, reticulum-cell sarcoma, or it may develop into polymorphous-cell sarcoma.

Giant follicular hyperplasia has been mistaken clinically for Hodgkin's disease. Its histologic picture, however, is distinctive. There is numerical and dimensional hyperplasia of lymph follicles, consisting exclusively of small lymphocytes. The follicles may remain intact or may rupture and permit escape of their cell components into the substance of the nodes. In the latter event the disease is transformed into polymorphous-cell sarcoma.

The author's patients ranged in age from twelve to fifty-nine years. There were 5 females and 14 males. Enlarged lymph nodes were the outstanding feature. These varied from 1 to 3 cm in diameter and presented no characteristics to distinguish them from the other lymphomas. Splenomegaly was present in 3 cases and in 1 the liver was enlarged. There was a persistent leukopenia in 4 patients.

Two-hundred kilovolt roentgen therapy was used to treat the lymph nodes and spleen, with two noteworthy variations in response. The nodes in giant follicular lymphadenopathy receded or disappeared under doses of 800 to 1000 r (measured in air). The nodes in polymorphous-cell sarcoma regressed only after doses of 2,000 to 3,000 r and frequently showed a latent period of reaction in contrast to the rapid disappearance of the nodes in giant follicular lymphadenopathy.

Sixty-six per cent of patients with giant follicular lymphadenopathy and 60 per cent of those with polymorphous-cell sarcoma are apparently well five or more years after institution of treatment. The disease develops and progresses slowly and in its early phase is reversible or curable. When a dedifferentiated structural modification has occurred, the course is irreversible and the outcome is fatal.

Seven illustrations

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RADIOACTIVE ISOTOPES

Study of Peripheral Vascular Disease with Radioactive Isotopes. Part I. Daniel C. Elkin, F. W. Cooper, Jr., R. H. Rohrer, W. B. Miller, Jr., Patrick C. Shea, Jr., and E. W. Dennis. Surg. Gynec. & Obst. 87 1-8 July 1948.

Two methods for the use of radioactive sodium 24 in the investigation of circulatory physiology of the extremities are compared and discussed.

One method consisted in the intravenous injection of radioactive sodium into the antecubital vein, with determination of the circulation time to the leg and to the foot, curves were obtained by plotting the counting rate of Geiger-Müller detectors against time. Variations in circulation time by this method were found to be so wide in normal individuals that results would be rendered valueless in the diagnosis of circulatory dis-

orders. A great many variables and uncontrollable factors are involved in the procedure.

The second method involved injection of radioactive sodium directly into muscle and recording its rate of removal. This was believed to permit an objective evaluation of the effective blood flow through the capillaries, for the removal of the sodium from the muscle depends upon the volume of blood flow. A linear expression of the removal rate of the sodium is obtained by plotting counts per minute against time on semilogarithmic paper. A numerical logarithmic expression "K" of the slope of the line is used for comparative studies. Such studies have been made in 115 individuals and are to be reported at a later date.

An electromechanical apparatus was designed for automatically recording impulses received from four Geiger-Müller tubes simultaneously. The counts are translated by electronic circuits into currents which activate pens of mechanical recorders.

Three photographs, 3 charts

ALLAN K. BRINEY, M D
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Thyrotoxicosis Factitia (Alimentary Thyrotoxicosis) Its Differentiation from Spontaneous Thyrotoxicosis with the Aid of Radioactive Iodine Bengt N Skanse and Douglas S Riggs J Endocrinol 8 532-543, July 1948

A case of secretly self-induced thyrotoxicosis (thyrotoxicosis factitia) is described, and a second case in which circumstantial evidence strongly favored the same diagnosis is also discussed. In both patients the clinical picture was indistinguishable from that of endogenous thyrotoxicosis. The differential diagnosis was facilitated by the use of tracer doses of radioactive iodine. In endogenous thyrotoxicosis the urinary excretion of radioactive iodine is low compared to that of euthyroid individuals. In thyrotoxicosis factitia the excretion of radioactive iodine is higher than normal. Since the serum protein-bound iodine is elevated independently of the source of iodine-containing hormone, this test is not contributory to the differential diagnosis. Other conditions which may produce the same condition of elevated serum protein-bound iodine and high excretion of radioactive iodine are discussed.

EFFECTS OF RADIATION

Basal Metabolism in Cancer Patients in Relation to Radiotherapy D Agostini and P Lorenzini Radiol med (Milan) 34 415-420 July 1948 (In Italian)

The authors studied the basal metabolic rate of 56 cancer patients before, during and after radiation therapy. From their observations they conclude that the basal metabolism rate is elevated 15 to 25 per cent in cancer patients before any treatment is given and goes even higher during radiation therapy, especially with radium. After treatment, the basal metabolism rate remained elevated in 48 per cent of the patients, was normal in 32 per cent and low in 20 per cent. The weight of the patients varied inversely as the basal metabolic rate.

Many breast cancers showed a decreased basal metabolism rate following treatment, probably because of radiation effect on the thyroid or upon the sympathetic chain.

One chart

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Generalized X-Ray Exanthema (Report of a Case) H Schreiber Radiol clin 17 207-212, July 1948 (In English)

A woman of 40 was given postoperative irradiation to the left chest and axilla following a microscopic diagnosis of carcinoma simplex of the breast and a wide excision of the mamillary region. She received 1,440 mg.hr to a palpable node in the axilla (type of radium applicator not stated) followed by a series of roentgen treatments with 1,000 r to the lateral, 1,200 r to the medial, and 200 r to the inferior part of the breast, and 1,200 r to the anterior and 1,600 r to the posterior axilla (200 kv, 4 ma, 0.5 mm copper and 1.0 mm aluminum filter, 10 x 15-cm fields, 40 cm focal skin distance, 200 r per treatment), 250 r additional were given to the scar (160 kv, 4 ma, 1.0 mm aluminum filter, 40 cm

FSD). This led to erythema and desquamation which two weeks following completion of the treatment was regressing. About three days after this, however, a dark red, painful area extending far beyond the treated area had appeared. The temperature was normal. Treatment with calcium and benadryl (on the supposition of an allergic reaction) was without effect and the lesion progressed, finally involving an area on the left forearm not in continuity with the rest of the lesion. This rash was partly homogeneous, partly composed of macules with a tendency to coalesce. The general condition remained good. A leukopenia of 2,400 white blood cells was noted, but was believed to be due to the previous irradiation. At the beginning of treatment, the percentage of eosinophils was 7, at the height of the reaction, it was between 2 and 3. Bland local applications were used, and recovery eventually occurred. The diagnostic possibilities are considered at some length, with the conclusion that this represents a non-specific generalized post-irradiation erythema.

Three drawings

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X-Ray Injuries The Preventable Occupational Hazard. Shirley J DeVoe and George M Corney New York State J Med 48 1601-1602, July 15, 1948

The fundamental points in x-ray and radium protection are emphasized rather briefly in this article. Some things are not given the proper emphasis, i.e., the discarding of old cracked gloves, the use of filters on the fluoroscopic tube, limitation of fluoroscopic time, the prime importance of distance in radium protection, etc. These are errors of omission, however, and since the things that are discussed involve every radiologist's daily life, it would be worth while to refresh one's memory by reading the article in the original.

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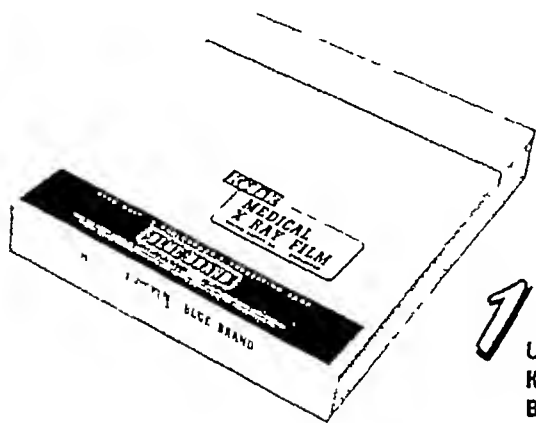


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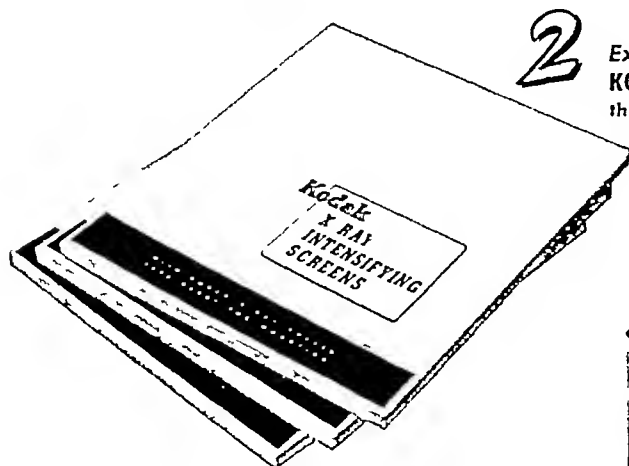
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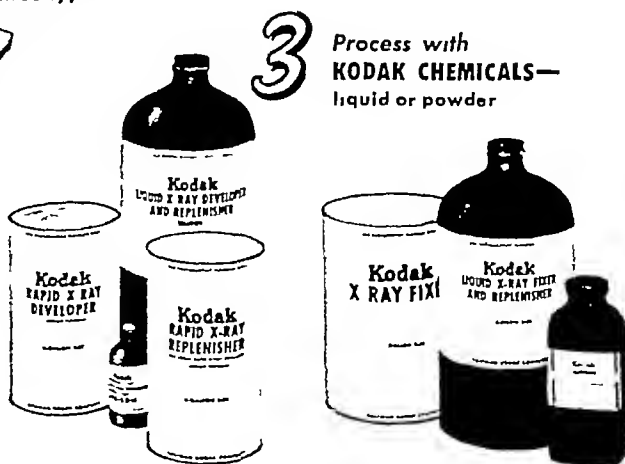
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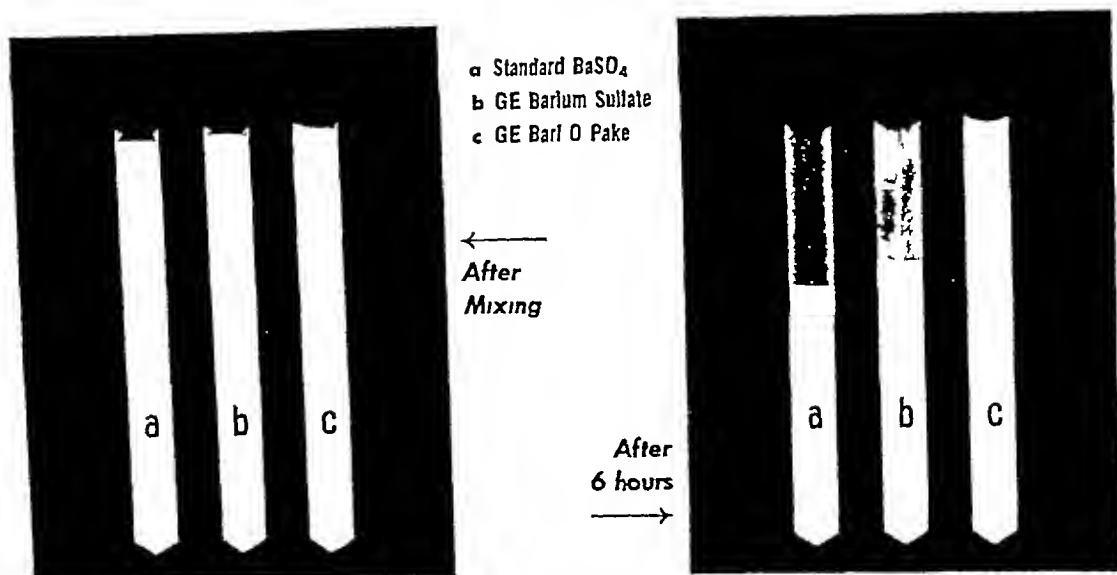
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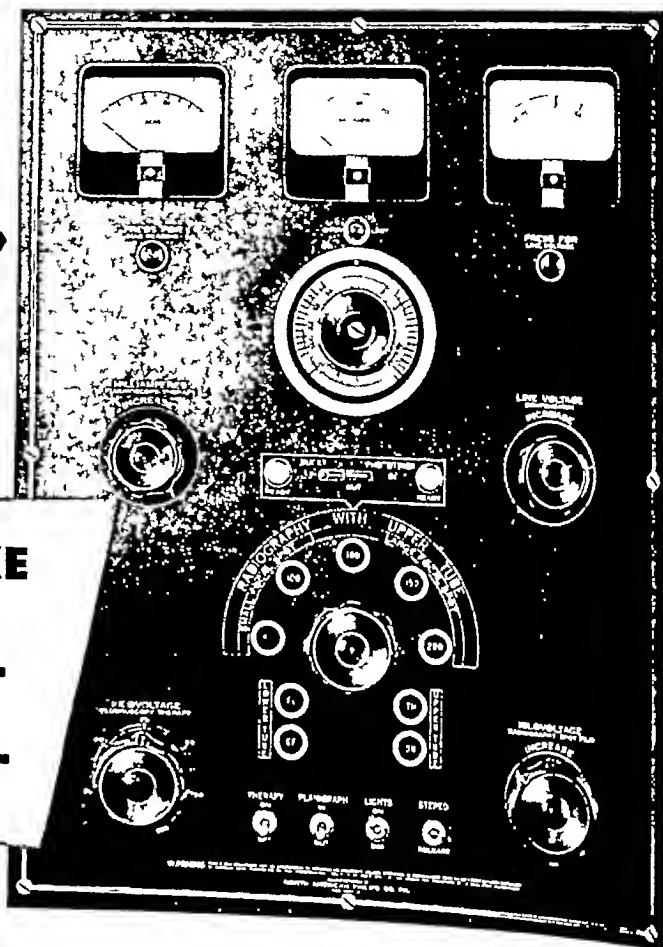
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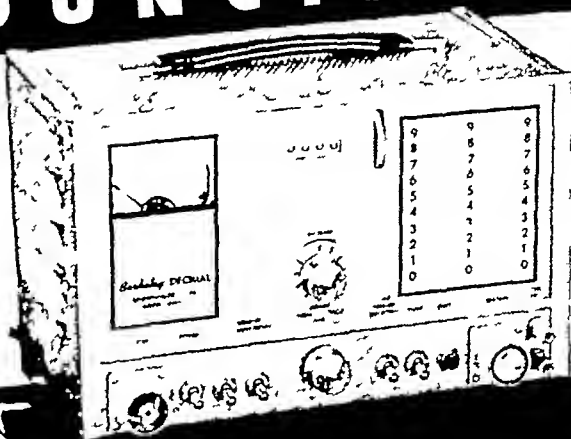
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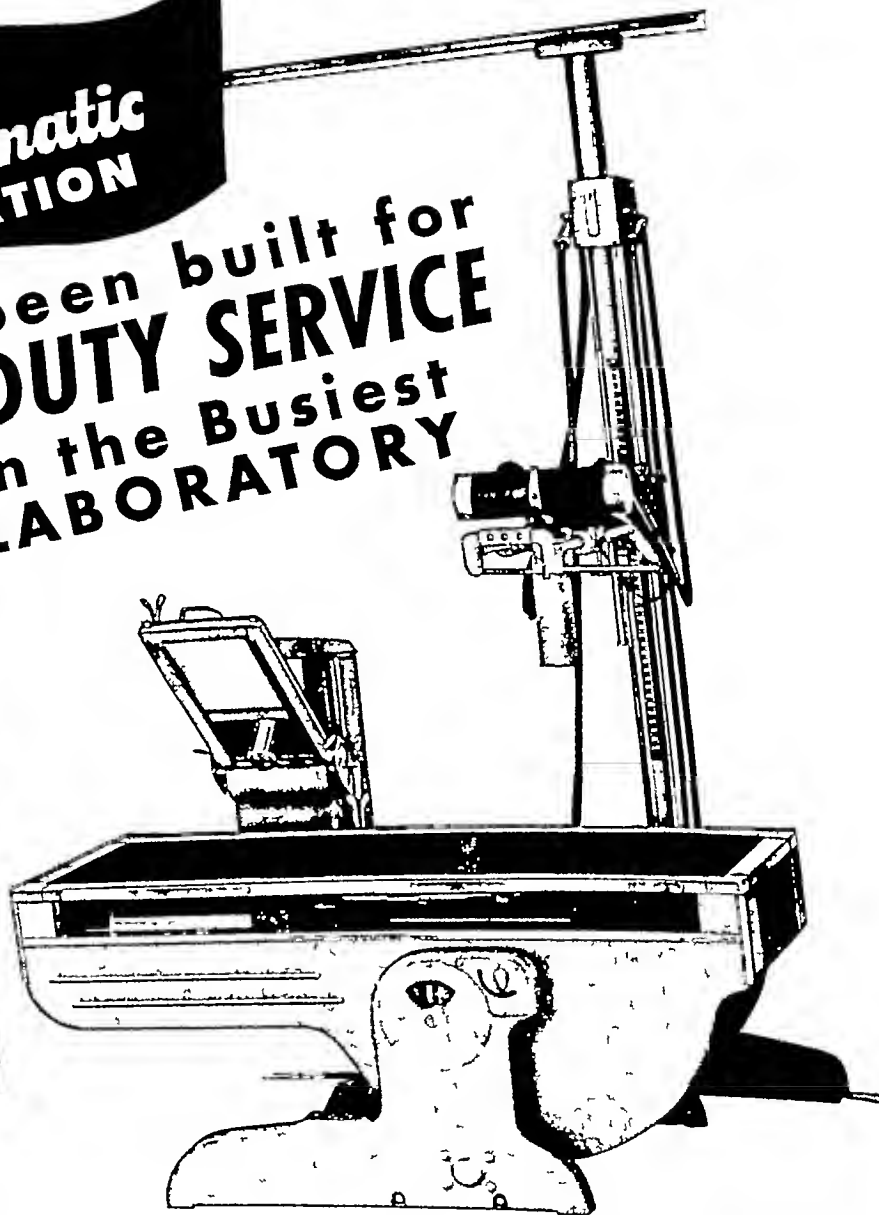
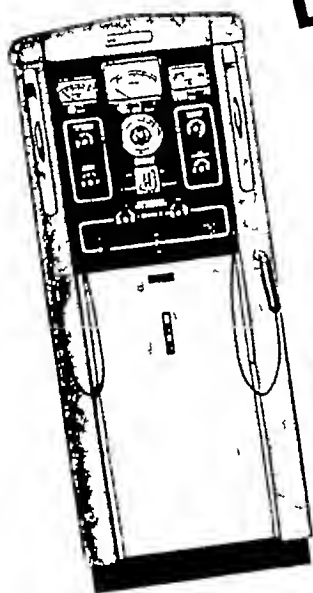
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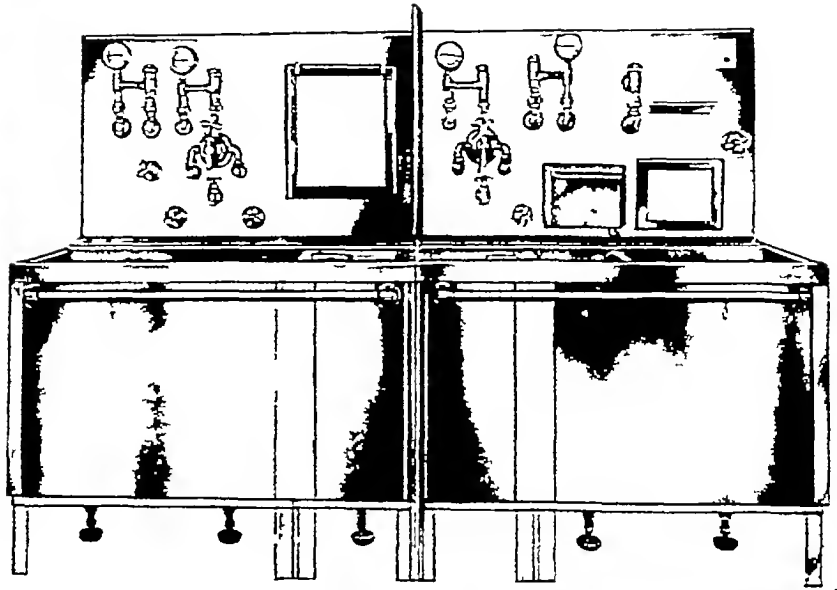
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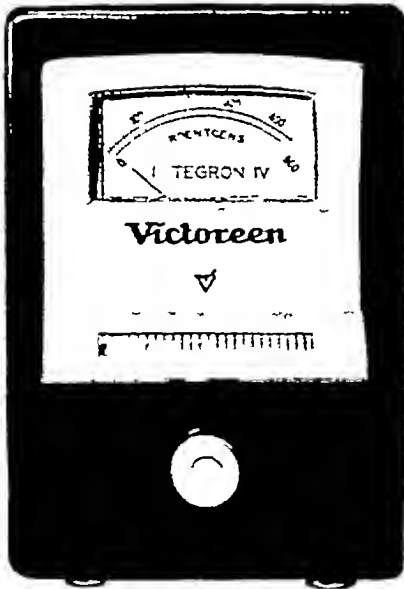
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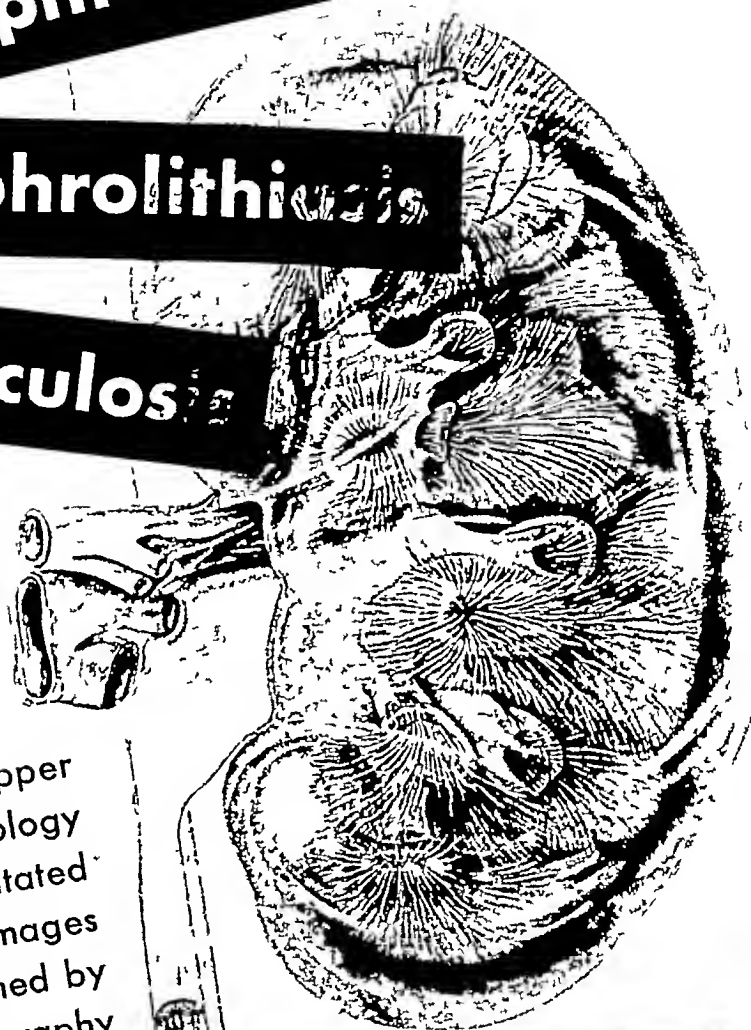
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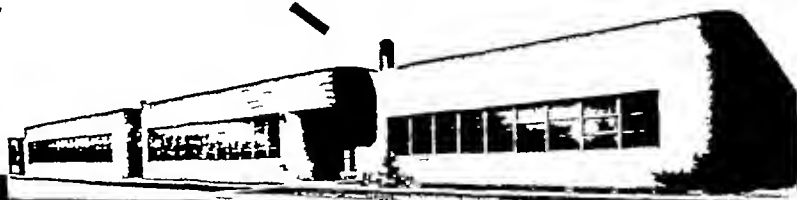
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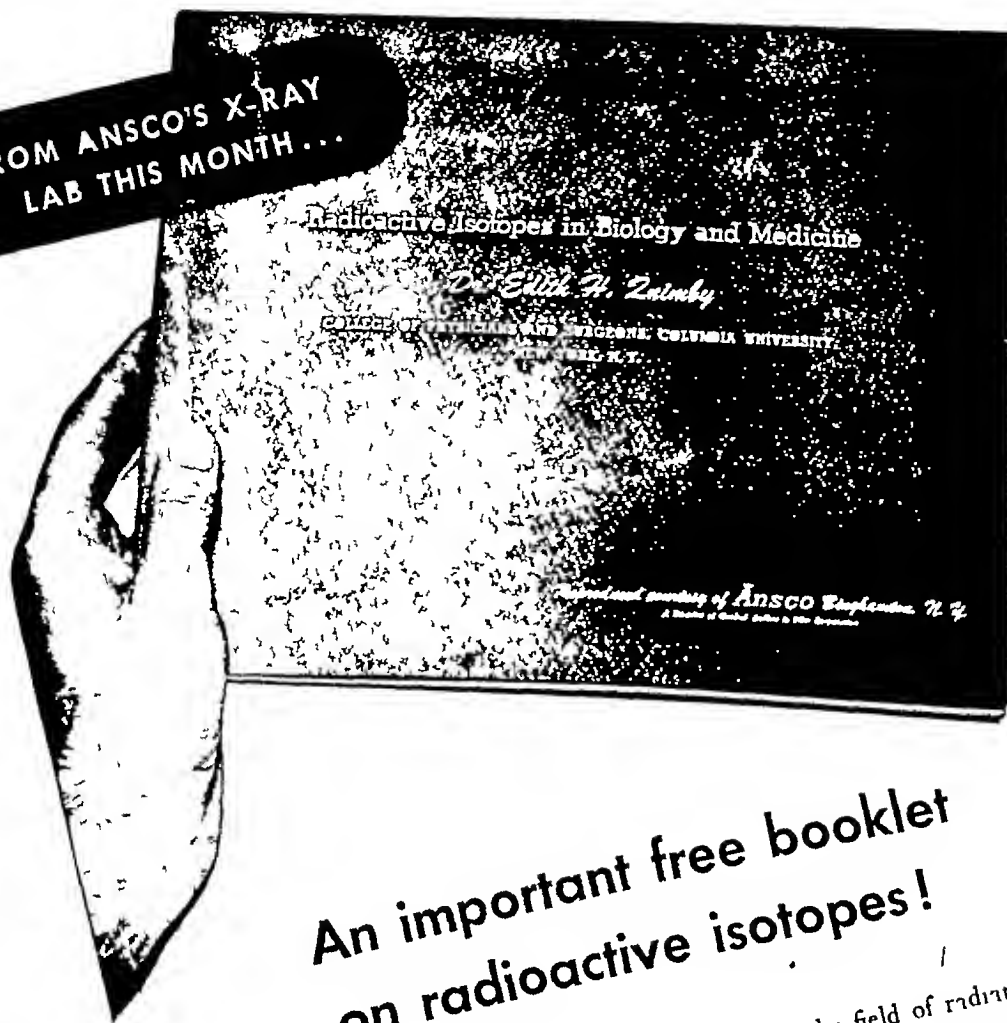
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